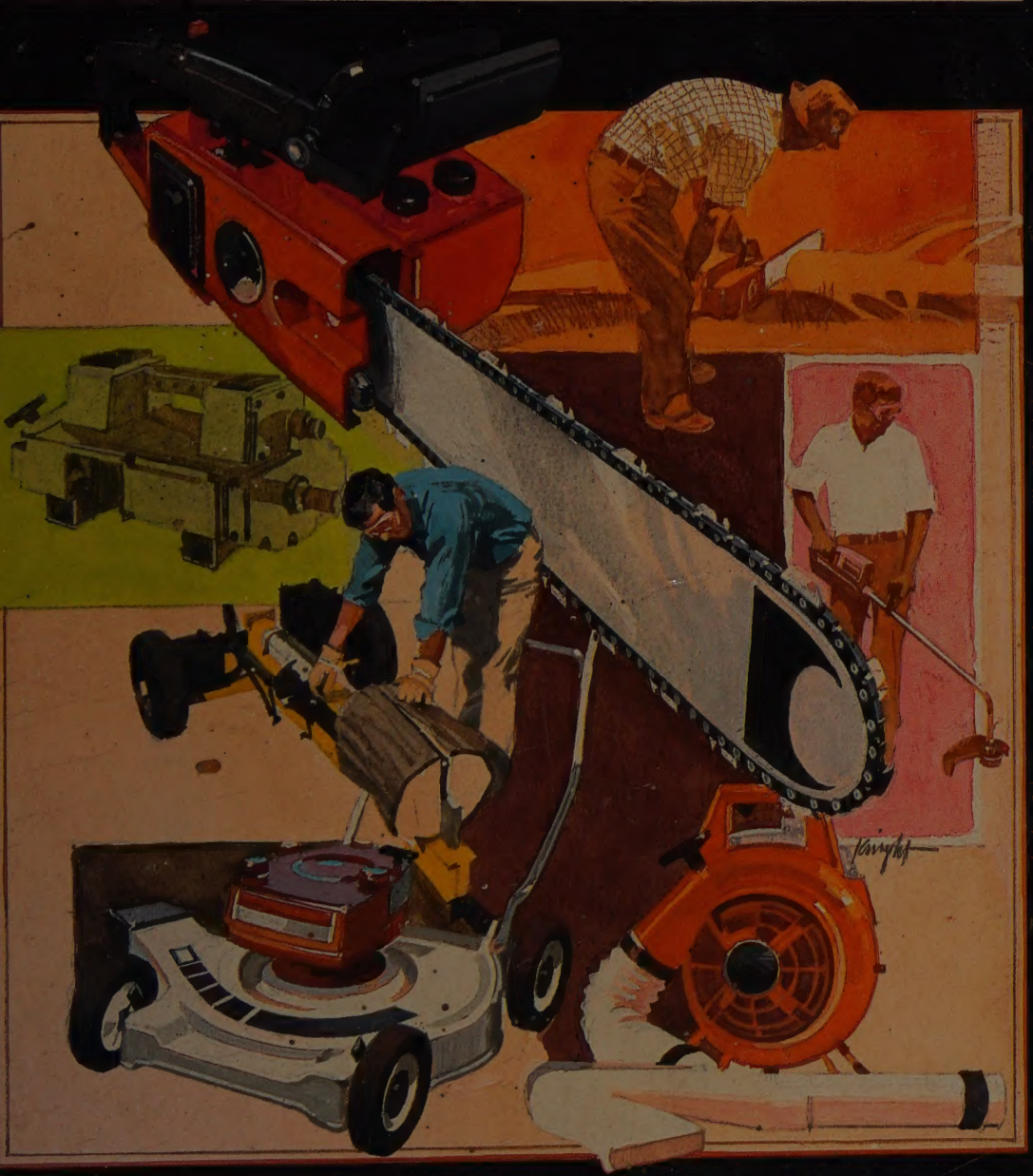
SPECIALTY CHILTON SERIES

CHILTON'S GUIDE TO SMALL ENGINE REPAIR

Up to 6 Hp



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Up to 6 Hp

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19089

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1

Engine Operation and General Information

HOW AN INTERNAL COMBUSTION ENGINE DEVELOPS POWER

The energy source that runs an internal combustion engine is heat created by the combustion of an air/fuel mixture. The combustion process takes place within a sealed cylinder containing a piston which is able to move up and down in the cylinder. The piston is connected to a crankshaft by a connecting rod. The lower end of the rod is connected to the crankshaft at a point which is offset from the centerline of the crankshaft, allowing it to turn a large circle. This is why the piston moves up and down, and why pressure on the top of the piston eventually becomes torque, or turning force, on the crankshaft.

The sealed cylinder, or "combustion chamber" traps the air/fuel mixture. When burning takes place in a confined space such as this, the heat it produces becomes pressure which can be used mechanically to produce power. As the fuel burns and the piston goes down, the chamber becomes larger and larger, allowing for continued use of this pressure. The fact that the size of the chamber changes with the position of the piston also allows the air/fuel to be compressed, or packed into a confined space before it is burned, which has the effect of greatly increasing the amount of pressure made by the heat of burning, and makes the engine produce more power on less fuel. The variable size of the chamber also permits the engine to do its own breathing—to expel burnt gases and pull in fuel and fresh air (see the description of the four events in the operating cycle of a four-stroke engine below).

As you can see from how the engine produces power, leakage from the combustion chamber will have a tremendous effect on operating efficiency. One of the most important aspects of engine overhaul work involves repair or replacement of parts so that the combustion chamber will be as tightly sealed as possible.

Four-Stroke Engines

The entire series of four events that occur in order for an engine to operate may take place in one revolution of the crankshaft or it may take two revolutions of the crankshaft. The former is termed a two-cycle engine and the latter a four-cycle engine.

The four events that must occur in order for any internal combustion engine to operate are: intake, compression, expansion or power, and exhaust. When all of these take place in succession, this is considered one cycle.

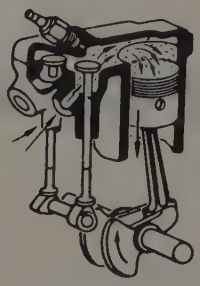
In a four-cycle engine, the intake portion of the cycle takes place when the piston is traveling downward, creating a vacuum within the cylinder. Just as the piston starts to travel downward, a mechanically operated valve opens, allowing the fuel/air mixture to be drawn into the cylinder.

As the piston begins to travel upward, the valve closes and the fuel/air mixture becomes trapped in the cylinder. The piston travels upward and compresses the air/fuel mixture. This is the compression part of the cycle.

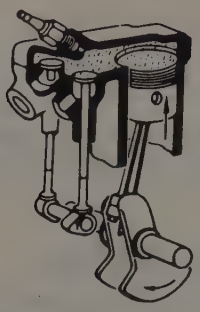
Just as the piston reaches the top of its stroke and starts back down the cylinder, an electric spark ignites the air/fuel mixture and the resulting explosion and rapid expansion of the gases forces the piston downward in the cylinder. This is the expansion or power stroke of the cycle.

Just as the piston reaches the end of its downward travel on the compression stroke, another mechanically operated valve is opened. The next upward stroke of the piston forces the burned gases out the opened valve. This is the exhaust stroke.

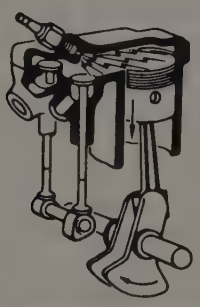
When the piston reaches the top of the cylinder, thus ending the exhaust stroke, the ex-



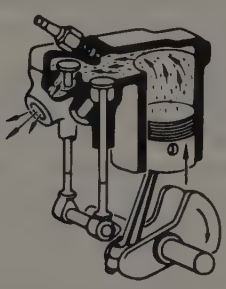
Intake stroke of a four-stroke engine



Compression stroke of a four-stroke engine



Power stroke of a four-stroke engine



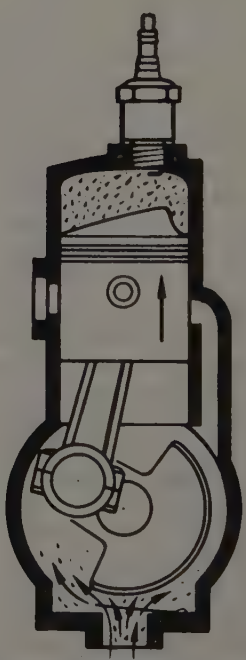
Exhaust stroke of a four-stroke engine

haust valve is closed and the intake valve opened. The next downward stroke of the piston is the intake stroke that the whole series of events began with.

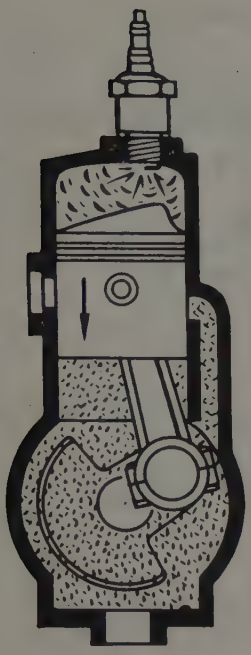
Two-Stroke Engines

In a two-stroke engine, intake, compression, power, and exhaust take place in one downward stroke and one upward stroke of the piston. The spark plug fires every time the piston reaches the top of each stroke, not every other stroke as in a four-stroke engine. (On some four-stroke engines, the magneto is operated by the crankshaft so that the spark plug actually fires once in every engine revolution. However, since the plug fires only into already burnt gases, this has no appreciable effect on engine operation.)

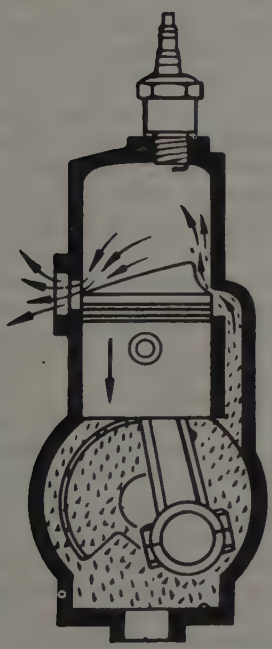
The piston in a two-cycle engine is used as a sliding valve for the cylinder intake and exhaust ports. The crankcase is used as a pump in order to slightly compress new fuel/air mixture and force it through the cylinder. In some designs, the piston also opens and closes a third port connecting the intake tube and carburetor to the crankcase. The intake and exhaust ports are both open when the piston is at the end of its downward stroke, which is called bottom dead center or BDC. Since the exhaust port is opened to the outside atmospheric pressure, the exhaust gases, which are under a much higher pressure due to combustion, will escape to the outside through the exhaust port. After the pressure of the exhaust gases has been somewhat relieved, the piston uncovers the intake port, and a fresh charge of air/fuel is pumped through the intake port, forcing the exhaust gases out in front of it. We say that the air/fuel mixture is being pumped into the cylinder because it is under pressure caused by the downward movement of the piston. In the most common type of two-stroke



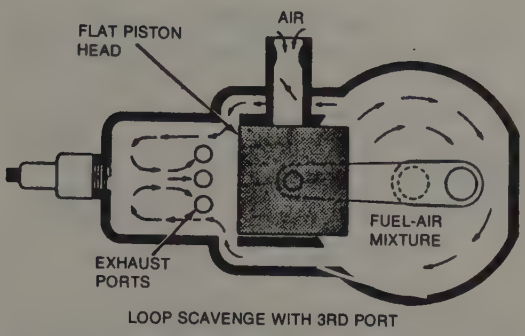
The compression stroke of a two-stroke engine; the intake port is open and the air/fuel mixture is entering the crankcase



The power stroke of a two-stroke engine; the intake port is closed and, as the piston is being forced down by the expanding gases above, the air/fuel mixture in the crankcase is being compressed



The exhaust stroke of a two-stroke engine; the piston travels past the exhaust port, thus opening it, then past the intake port, opening that. As the exhaust gases flow out, the air/fuel mixture flows in due to being under pressure in the crankcase. The next stroke of the piston is the compression stroke and the series of events starts over again

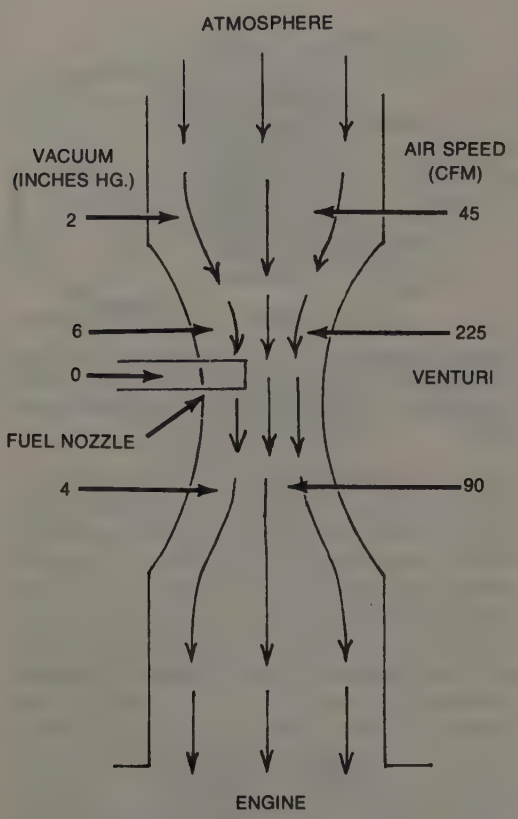


Some engines use a third port, which is opened and closed by the bottom of the piston, to control the admission of air/fuel mixture into the crankcase

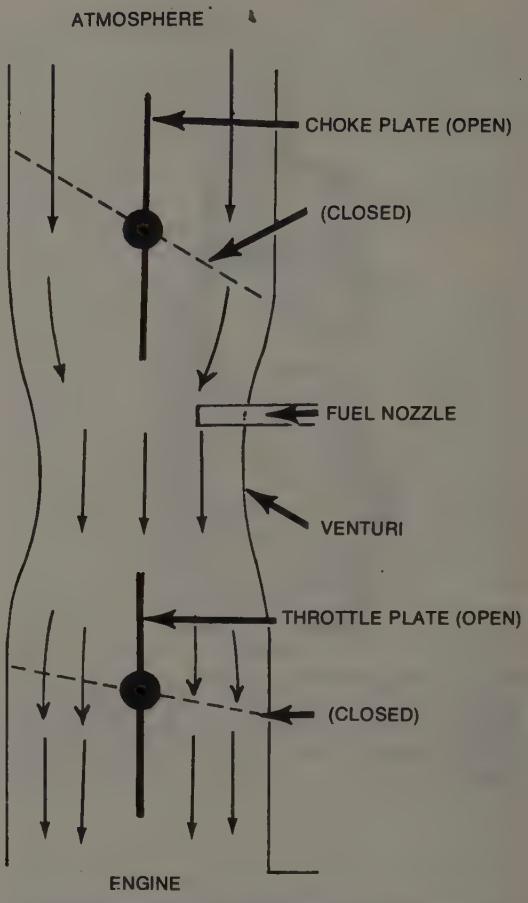
engine, the air/fuel mixture is drawn through a one-way valve, known as a reed valve, and into the crankcase by the vacuum caused by upward movement of the piston. When the piston reaches top dead center or TDC and starts back down, the one-way valve in the crankcase is closed by its natural spring action and the building pressure caused by the downward movement of the piston. In the three port type of engine, the upward movement of the piston creates a vacuum in the crankcase. When the skirt (bottom) of the piston uncovers the third port as the piston nears the top of its travel, the vacuum in the crankcase draws in air/fuel mixture. As the piston descends, the third port is again covered by the piston skirt, and the crankcase is sealed for compression of the mixture. The air/fuel mixture is compressed until the piston moves past the intake port, thus allowing the compressed mixture to enter the cylinder. The piston starts its upward stroke, closing off the intake port and then the exhaust port, thus sealing the cylinder. The air/fuel mixture in the cylinder is compressed and at the same time, a fresh charge of air/fuel mixture is being drawn into the crankcase. When the piston reaches TDC, a spark ignites the compressed air/fuel mixture and the resulting expansion of the gases forces the piston back down the cylinder. The piston passes the exhaust port first, allowing the exhaust gases to begin to escape. The piston travels down the cylinder a little farther and past the intake port. The fresh air/fuel mixture in the crankcase, which was compressed by the downward stroke of the piston, is forced through the intake port and the whole cycle starts over.

FUEL SYSTEMS

The fuel system in a small engine consists of a fuel supply or storage vessel, a fuel pump, various fuel lines, and the carburetor. Fuel is



All carburetors operate on the venturi principle. The numbers represent hypothetical ratios of air speed and vacuum in relation to the venturi. Zero vacuum at the fuel nozzle is atmospheric pressure



The positioning of the choke and throttle plates in relation to the position of the venturi

stored in the fuel tank and pumped from the tank into the carburetor. Most small engines do not have an actual fuel pump. The carburetor receives gasoline by gravity feed or the fuel is drawn into the carburetor by venturi vacuum. The function of the carburetor is to mix the fuel with air in the proper proportions.

Types of Carburetors

Small engine carburetors are categorized by the way in which the fuel is delivered to the carburetor fuel inlet passage in the venturi (fuel nozzle).

PLAIN TUBE CARBURETORS

Carburetors used on engines that run at a constant speed, carrying the same load all of the time, can be relatively simple in design because they are only required to mix fuel and air at a constant ratio. Such is the case with plain tube carburetors.

All carburetors operate on the principle that a gas will flow from a large or wide volume passage through a smaller or narrower volume passage at an increased speed and a decreased pressure over that of the larger passage. This is called the venturi principle. The narrower passage in the carburetor where this acceleration takes place is therefore called the venturi.

A fuel inlet passage is placed at the carburetor venturi. Because of the reduced pressure (vacuum) and the high speed of the air rushing past at that point in the carburetor, the fuel is drawn out of the passage and atomized with the air.

The fuel inlet passage, in most carburetors, can regulate how much fuel is allowed to pass. This is done by a needle valve which consists of a tapered rod (needle) inserted in the opening (seat), partially blocking the flow of fuel out of the opening. The needle is movable in and out of the opening and, since it is tapered at that end, it can regulate the flow of fuel.

The choke of a plain tube carburetor is located before the venturi or on the atmospheric side. The purpose of the choke is to increase the vacuum within the carburetor during low cranking or starting speeds of the engine. During cranking speeds, there is not enough vacuum present to draw the fuel out through

the inlet and into the carburetor to become mixed with the air. When the choke plate closes off the end of the carburetor open to the atmosphere, the vacuum condition in the venturi increases greatly, thus enabling the fuel to be drawn out of the opening.

In most cases the choke is manufactured with a small hole in it so that not all air is blocked off. When the engine starts, the choke is opened slightly to allow more air to pass. The choke usually is not opened all the way until the engine is warmed up and can operate on the leaner fuel/air mixture that comes into the engine when the choke is completely opened and not restricting the air flow at all. Thus, the choke also provides the richer mixtures (more fuel for the amount of air) required when the engine is cold.

Many of the chokes used on small engine carburetors are entirely automatic. In many cases, the choke is required to provide just sufficient vacuum to get the fuel moving and give rich mixture during cranking. Once the engine is running, the choke can be opened in just a few seconds without causing it to stall. It will run fairly well on a normal, lean mixture because the carburetor is close to the engine and puddling of fuel that occurs in engines with long manifolds while they are cold is no problem.

This type of choke is held shut by the pressure of a spring, and opened by the action of a diaphragm. Manifold vacuum is fed to the side of the diaphragm on which the spring is located through a small orifice. There is no vacuum when the engine is stopped, but upon starting, manifold vacuum gradually draws air out of the diaphragm chamber, and draws the diaphragm downward, against spring pressure. A rod linking the diaphragm to the choke then pulls it open.

This type of choke is also capable of keeping the mixture adequately rich during sudden increases in throttle opening; vacuum normally gets very low under these circumstances, and the choke tends to close slightly as the throttle opens, thus aiding fuel flow.

The throttle plate in a carburetor is installed on the engine side of the venturi. The purpose of the throttle plate is to regulate the flow of air/fuel mixture going into the engine. Thus the throttle plate regulates the speed and power output of an engine. By restricting the flow of air/fuel mixture going into the engine, the throttle plate is also restricting the combustion explosion and the energy created by the explosion.

These are the basic components required for any carburetor to operate on an engine. It is possible for such a carburetor to be installed on an engine and work. However, most engines operate at various speeds, under various load conditions, at different altitudes, and in a variety of temperatures. All of these variations require that the fuel/air mixture can be changed on command. In other words, the simple plain tube carburetor is not sufficient in most cases.

SUCTION CARBURETOR

Next to the plain tube carburetor, this is the simplest in design. With this type of carburetor, the fuel supply is located directly below the carburetor in a fuel tank. In fact, the carburetor and fuel tank are considered one assembly in most cases because a pipe extends from the carburetor venturi down into the fuel tank. When the engine is running, the partial vacuum in the venturi, and the relatively higher atmospheric pressure in the fuel tank, force the fuel up through the fuel pipe and into the carburetor venturi. There is a check ball located in the bottom of the pipe that prevents the fuel in the pipe from draining back into the fuel tank when the engine is shut down. In most engines there is a screen located at the end of the pipe to prevent dirt from entering and blocking the fuel nozzle.

Some suction carburetors are designed with an extra fuel inlet passage for when the engine is idling. This extra passage would be located on the engine side of the throttle plate. Since the vacuum condition in front of an idling engine might not be enough for the fuel to be drawn out at that point, the extra passage is installed behind the throttle plate where the vacuum is great enough to draw the fuel out. This extra fuel inlet passage would also have a regulating needle as does the main inlet.

FLOAT TYPE CARBURETORS

The fuel tank used with float type carburetors is usually located on top of, or at least above, the level of the carburetor. Fuel is fed to the carburetor by gravity. If the fuel tank is located below the level of the carburetor, a fuel pump is employed to pump fuel to the carburetor. Fuel enters the carburetor through a valve and into a float bowl and, as it fills the bowl, a float rises on the surface of the fuel. The float is connected to the inlet valve and, as the level rises, a needle is inserted into the inlet valve and the flow coming into the float bowl is checked. As the fuel is drawn into the main fuel nozzle in the venturi and the level in the bowl drops, the float drops and the needle opens the valve allowing more fuel to run into the bowl.

Although there are many different float carburetors, all operate in this manner.

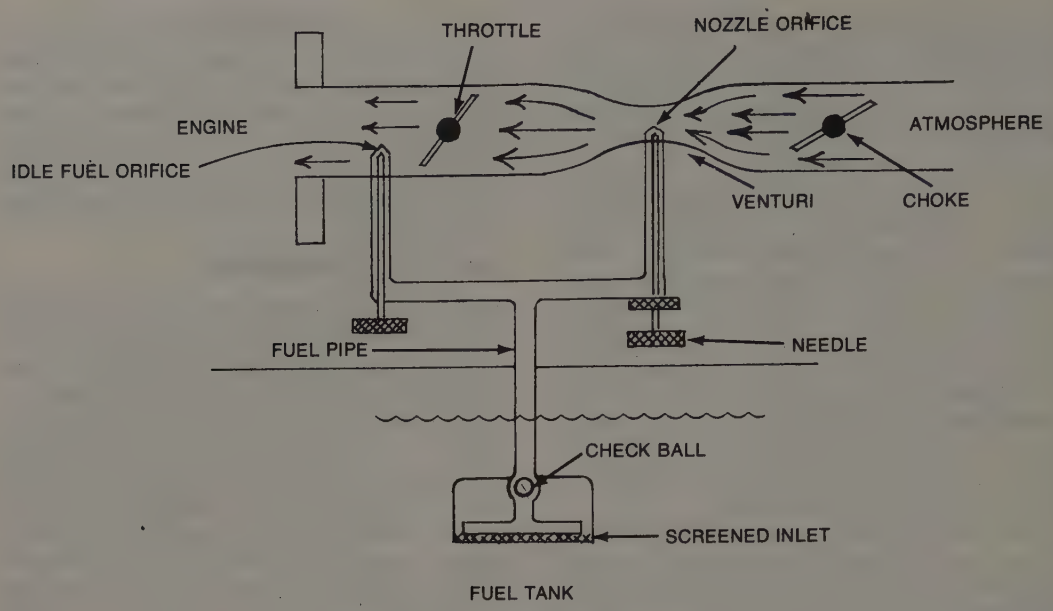


Diagram of a suction type carburetor

DIAPHRAGM TYPE CARBURETORS

Fuel is delivered to the diaphragm type carburetor in the same manner as to the float type carburetor.

A flexible diaphragm operates the fuel inlet valve, hence the description "diaphragm carburetor."

Atmospheric pressure is maintained on the under side of the diaphragm by a vent hole in the bottom of the carburetor. The other side of the diaphragm is acted upon by the varying vacuum conditions in the carburetor.

When the vacuum condition in the carburetor is increased by the opening of the throttle plate, and the demand for an increased flow of fuel, the center diaphragm is bellowed upward by the increased vacuum. The center of the diaphragm is connected by a lever to the fuel inlet valve needle. The needle is dropped down away from the inlet valve and fuel is allowed to drop in. When the throttle plate is closed and the need for fuel is reduced, the vacuum condition also decreases and the diaphragm is returned by a spring located on the atmospheric side to its normal flattened position. This closes the fuel inlet valve by raising the needle up into position against its seat.

This type of carburetor also has an idle orifice positioned behind the throttle plate to compensate for the low vacuum condition in front of the throttle plate during idle speeds.

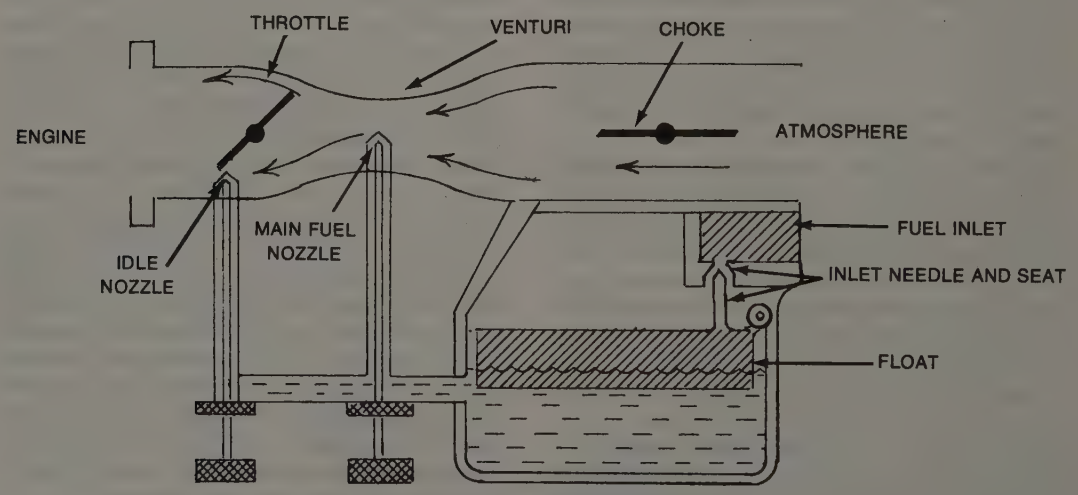


Diagram of a float type carburetor

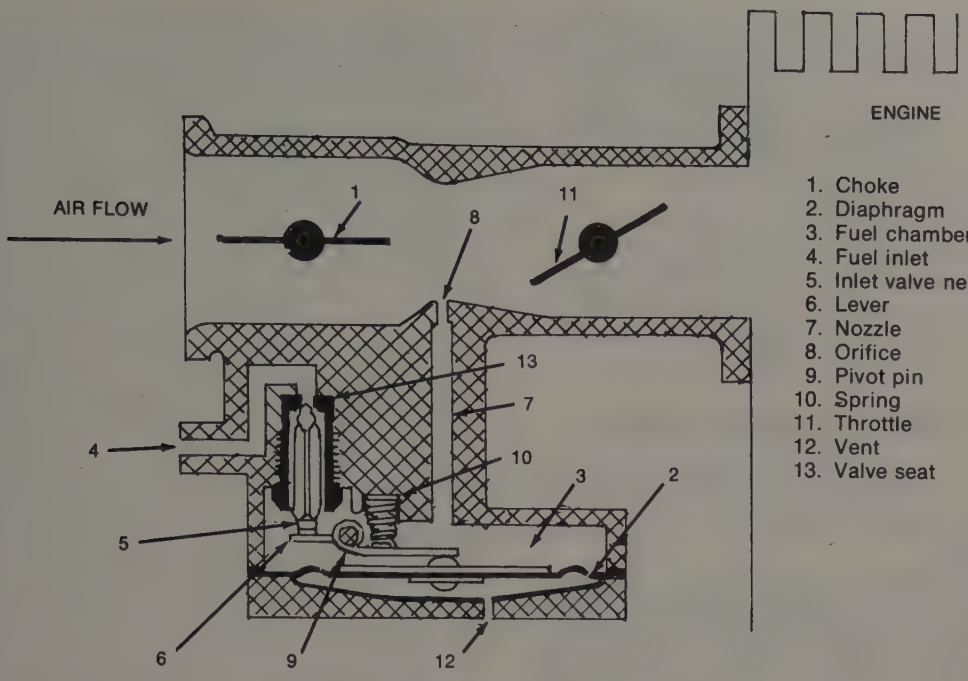
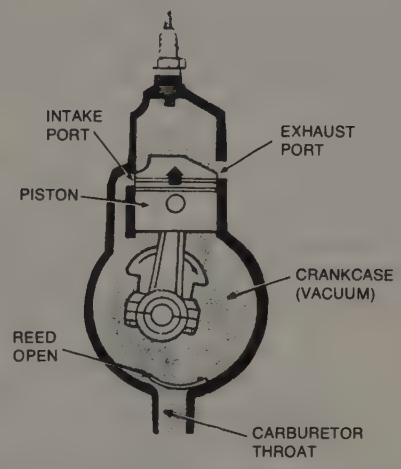


Diagram of a diaphragm type carburetor

Some diaphragm type carburetors incorporate an integral fuel pump. It consists of a second diaphragm having fuel on one side, and exposed to the pressue fluctuations of the crankcase or the intake manifold on the other side. The vibration of this diaphragm, in conjunction with the action of check valves in the passages leading to and from the fuel side of the diaphragm chamber work together to pump fuel, under pressure, to the fuel inlet valve.

REED VALVES

Reed valves are used on those two stroke engines in which the intake tube leading from the carburetor empties right into the crankcase. The reed serves as a kind of check valve, so that air/fuel cannot be forced back out of the crankcase. When the piston begins to rise, a slight vacuum is created under it, sucking the reed open against its spring pressure, as shown in the illustration. When the piston reaches the top of its travel, and the pressure in the crankcase gets near to outside (atmospheric) pressure, the valve's spring action pulls it flat against the intake opening (the reed is really a kind of flat spring). Then, as the piston descends, the build-up in pressure in the crankcase, in combination with the slight amount of oil that gets onto the reed, seals the intake very tightly, forcing practically the full charge into the cylinder.



The reed valve in the open position (piston moving upward)

IGNITION SYSTEMS

The function of an ignition system is to provide the electrical spark that ignites the air/fuel mixture in the cylinder at precisely the correct time. The two types of ignition systems used on small engines are either a battery ignition or a magneto ignition. The difference between

the two types are where they get their initial electrical charge from. The battery ignition, as the name implies, gets its initial electrical charge from a storage battery. The magneto ignition actually generates its own electricity, thus eliminating the need for a battery as far as ignition is concerned.

Battery and magneto ignition systems are similar in one respect. Both systems take a relatively small amount of voltage, such as 12 volts in the case of a battery ignition, then step up that to an extremely high voltage, in some systems as high as 20,000 volts.

Basic Battery Ignition System

Battery ignition systems are found mostly on larger one cylinder engines, such as those installed on lawn tractors, larger pumps and generators.

As previously stated, the initial electrical charge comes from a storage battery. The entire ignition system is grounded so that current will flow from the battery throughout the primary circuit.

The ignition system is composed of two segments, the primary circuit and the secondary circuit. Current from the battery flows through the primary circuit and the current that fires the spark plug flows through the secondary circuit. The current in the primary circuit actually creates the secondary current magnetically.

When the engine is running, current flows from the battery, through the breaker points, and on to the ignition coil. The current then flows through the primary windings of the coil which are wrapped around a soft iron core and grounded. The primary current flowing through these primary windings causes a magnetic field to be created around the soft iron core of the coil. At precisely the right time, the breaker points open and break the primary circuit, cutting off the flow of current coming from the battery. This causes the magnetic field in the coil to collapse toward the center of the soft iron core. As the field collapses, the lines of force of the magnetic field must pass through the secondary windings of the coil. These windings are also wrapped around the soft iron core of the coil, except that there are many more windings and the wire is thinner than those of the primary windings. When the magnetic field collapses and passes through the secondary windings, current flow is induced in the secondary circuit which is grounded at the spark plug. Because the wire of the secondary windings is smaller and there are many more coils around the soft iron core, the current created or induced in the secondary side of the ignition is of much greater voltage than the primary side. This current in the secondary circuit flows toward the grounded end of the circuit which is the spark plug. The current flows down the center of the spark plug to the center electrode. In order to reach the ground, it must jump across a gap to the grounded electrode. When it does, a spark is created and it is this spark that ignites the air/fuel mixture in the cylinder.

Magneto Type Ignition Systems

Magneto ignition systems create the initial primary circuit current, thereby eliminating the need for ignition batteries.

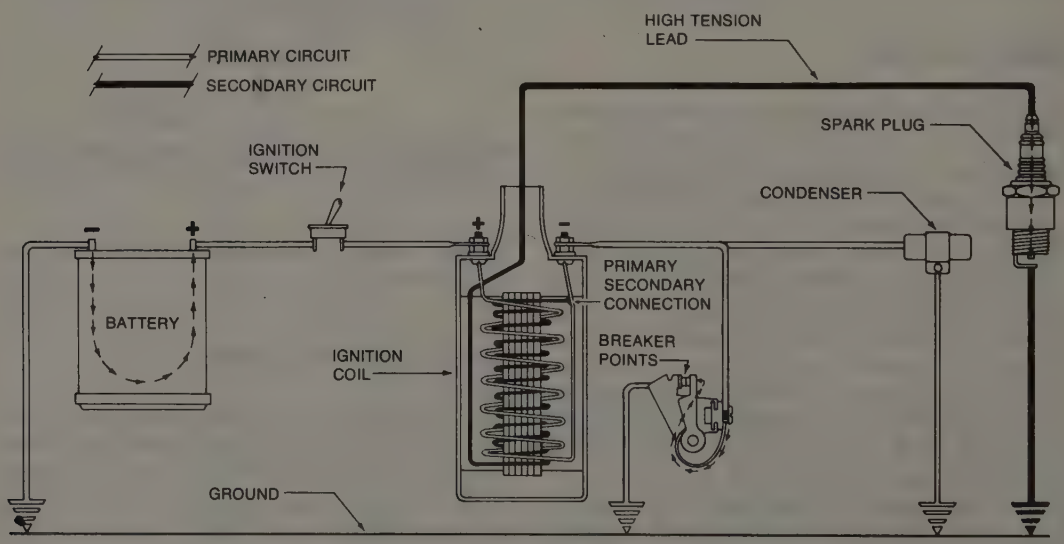


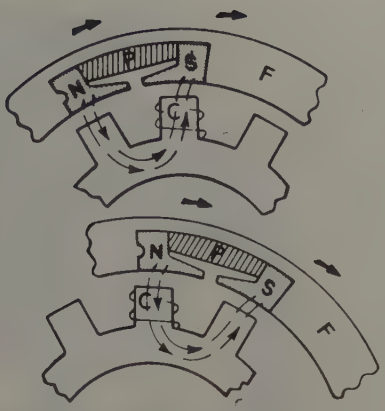
Diagram of a battery type ignition for a single cylinder engine

Flywheel Type Magnetos

On this type of magneto, the flywheel of the engine carries the permanent magnets that are used to create the primary current.

The magnets are arranged so that about ⅓ of the area enclosed by the flywheel is a magnetic field. In the center of the flywheel is a three pronged coil, the three prongs representing the core. The center prong has the primary and secondary windings and is set up just like a battery ignition coil.

As the magnets in the flywheel pass the two outside prongs, the primary current is induced in the coil and a magnetic field is set up around the center prong. At the point when the primary current is at its strongest which is also the time when the secondary current is needed at the spark plug, the breaker points interrupt the primary current, causing the magnetic field to collapse through the secondary windings. This induces the secondary current which flows to the grounded spark plug.



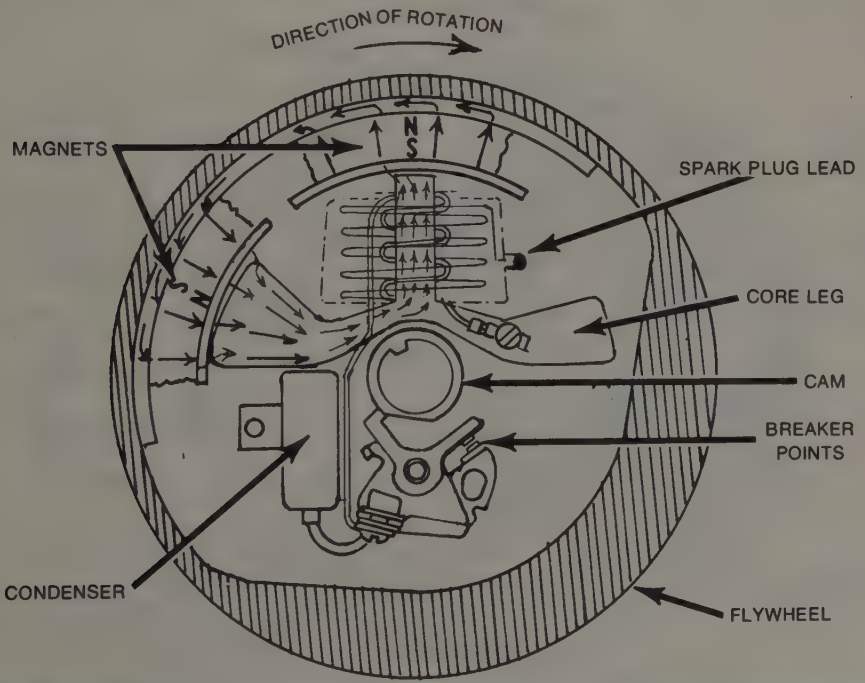
P—PERMANENT MAGNET
N—NORTH POLE SHOE
S—SOUTH POLE SHOE
F—FLYWHEEL
C—LAMINATED COIL CORE

A cutaway view of a flywheel used in a flywheel magneto. The magnets are arranged so that there is a magnetic field covering about ⅓ of the area enclosed by the flywheel. On flywheel magnetos where the coil and core are mounted on the outside of the flywheel, the magnets would be arranged on the outside of the flywheel

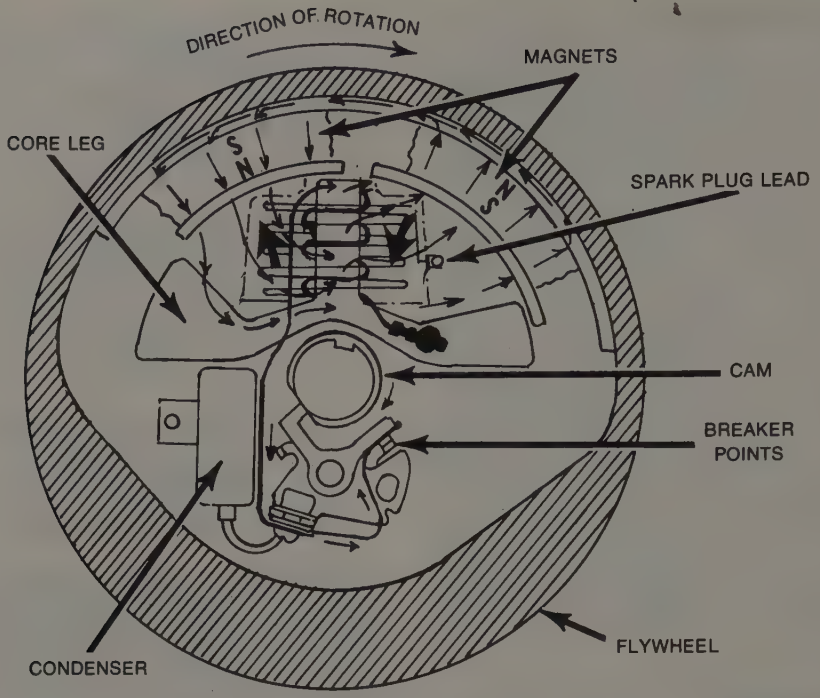
Unit Type Magnetos

Unit type magnetos operate in the same way as flywheel magnetos.

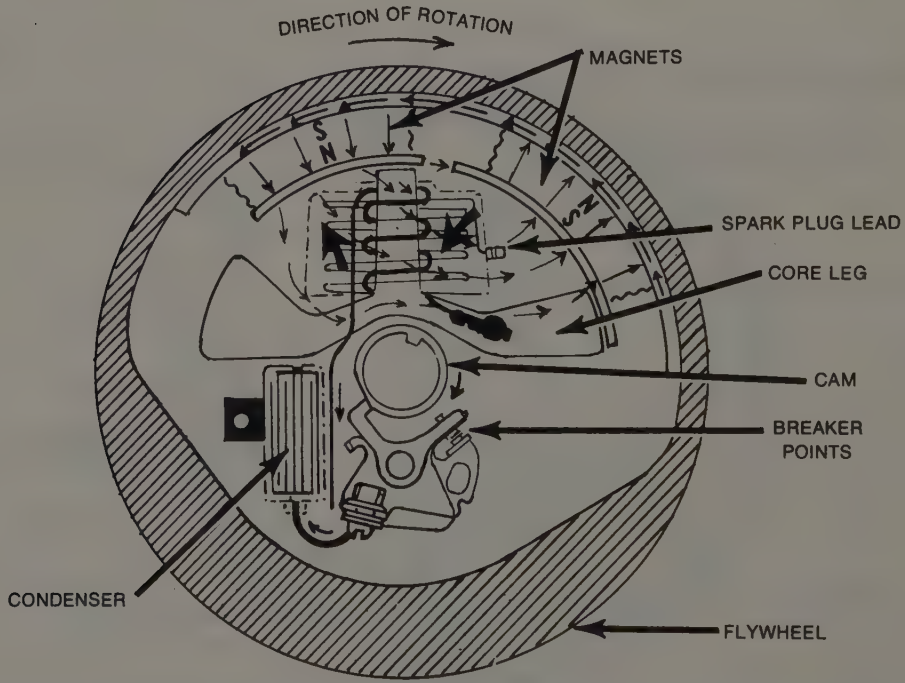
Permanent magnets are rotated through a mechanical connection to the crankshaft of the engine. The rotating magnets create the primary current which is routed through the breaker points and on to windings around a soft iron core which is also wrapped by the secondary windings. At precisely the right



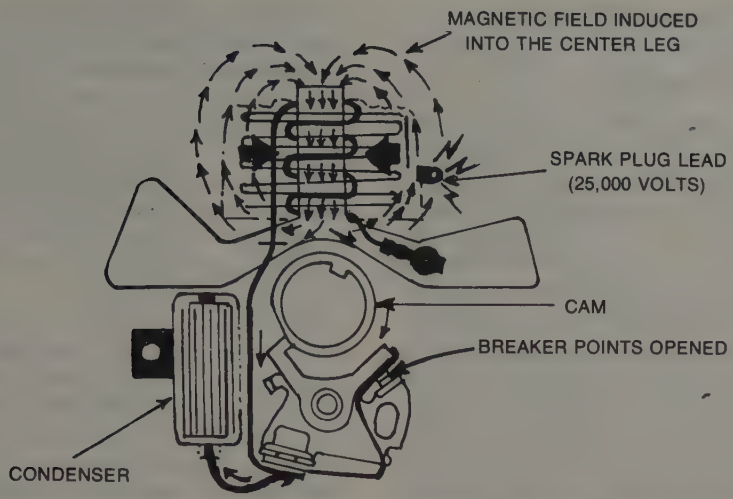
The three legs of the core pass through the magnetic field created by the rotating magnets. In this position, the lines of force are concentrated in the left and center core legs and are interlocking the coil windings



The flywheel has turned to the point where the lines of force of the permanent magnets are being withdrawn from the left and center cores and are being attracted by the center and right cores. Since the center core is both drawing and attracting the lines of force, the lines are cutting up one side and down the other (indicated by the heavy black arrows). The breaker points are now closed and a current is now induced in the primary circuit by the lines of force cutting up and down the center core leg



With the induced current in the primary windings, a magnetic field is created around the center core leg (coil). When the field is created around the center leg, the points are opened and the condenser begins to absorb the reverse flow of current



When the breaker points are opened, the induced magnetic field collapses. The collapsing of the magnetic field induces the secondary current into secondary windings leading to the spark plug

moment, the points interrupt the primary current, causing the magnetic field to collapse through the secondary windings and inducing the secondary current to the spark plug.

Because the magnets in the unit magneto are driven by the crankshaft of the engine through a gear mechanism, starting is a problem. At starting speeds, the magnets in the magneto cannot be rotated fast enough to create a primary current. To overcome this difficulty, unit magnetos have an impulse coupling on their shaft which drives the magnets. When the engine is turned over at starting speed, a catch engages a coil spring that is wound up in much the same manner as those that propel wind-up toys. As the shaft rotates further, it releases the spring. The spring unwinds rapidly, spinning the magnets fast enough to cause the primary current to be induced in the primary circuit. When the engine starts to run, centrifugal force keeps the catch in the impulse coupling from engaging the wind-up spring.

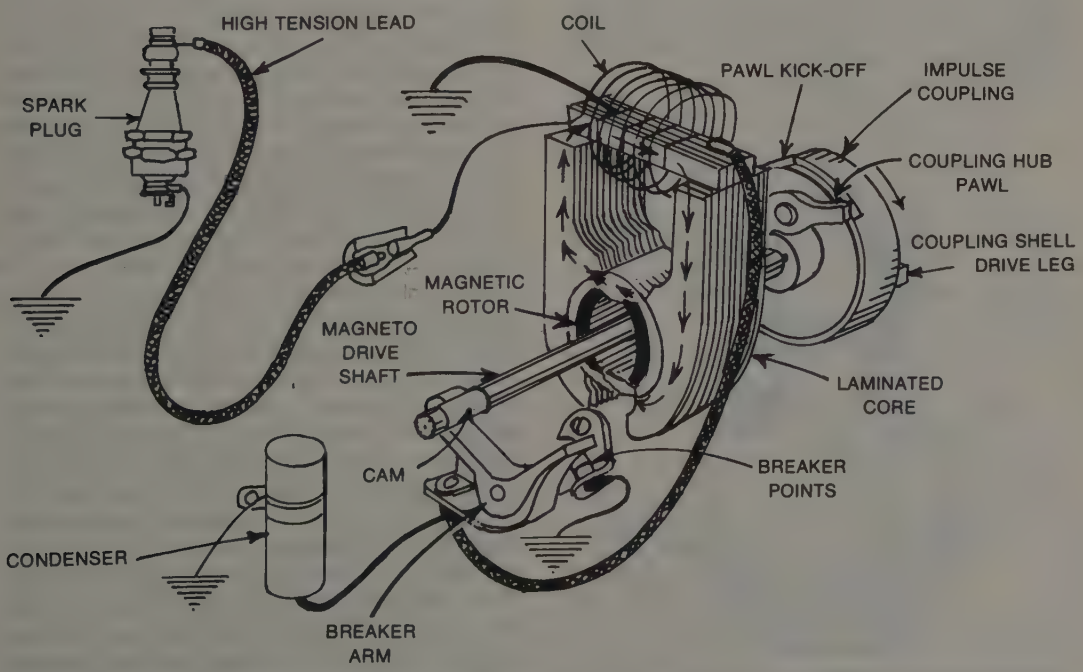


Diagram for a unit type magneto for a single cylinder engine

LUBRICATION SYSTEMS

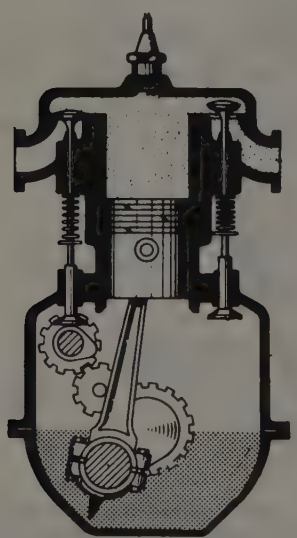
Four-Stroke Engines

Most small four stroke engines are lubricated by the splash system. All vital moving parts are splashed with lubricating oil that is stored in the crankcase. The connecting rod bearing gap usually has an arm extending down into the area in which the oil lies. As the crankshaft turns, the arm, commonly called a dipper, splashes oil up onto the cylinder walls, crankshaft bearings and camshaft bearings. In some cases, the connecting rod bearing cap screws are locked in place by lock plates which double as oil dippers. When the lock plate's tabs are bent up beside the cap screws, they extend a little past the tops of the screws and, when they enter the oil, they provide a sufficient splash to lubricate the engine.

In larger four stroke engines, a pressure system is used to lubricate the engine. This type of lubrication system pumps the oil through special passages in the block and to the components to be lubricated. In some cases, the camshaft and crankshaft have their center drilled so that oil can be pumped through the center and to the bearing journals. Most oil pumps in small engines are gear types.

In addition to lubricating the engine, oil in four stroke engines has other important functions. One of those additional functions is to help cool the engine. The oil actually absorbs heat from high temperature areas and dissipates it throughout other parts of the engine that are not directly exposed to the very high temperatures of combustion.

Oil in the crankcase also functions as a sealer. It helps to seal off the combustion chamber (top of the piston) from the crankcase, thus maintaining compression which is vital to satisfactory engine operation, while at the same time lubricating the cylinder walls and piston rings.



Lubrication of a four-stroke engine

Engine oil also keeps harmful bits of dust, metal, carbon, or any other material that might be present in the crankcase, in suspension. This keeps potentially harmful abrasives away from vital moving parts.

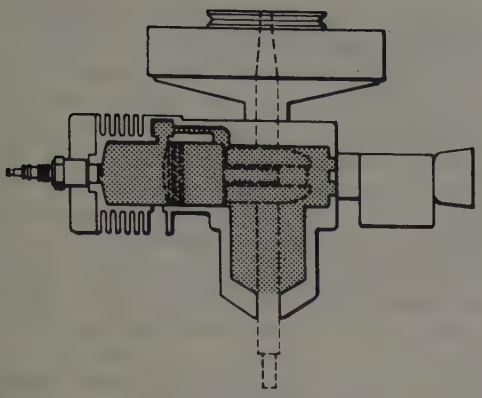
Most manufacturers recommend a good grade, medium weight detergent oil for their engines. The detergent properties of engine oil do not mean that the oil is capable of cleaning away dirt or sludge deposits already present in the engine. It means that the oil will help fight the formation of such deposits. In other words, the oil keeps the dirt in suspension.

A certain amount of combustion leaks past the piston rings and into the crankcase. Raw gas, carbon, products of combustion, and other undesirable material still manage to make their way into the lubricating oil. The oil becomes diluted by the gas and loses its cooling properties. When it is filled with abrasives, it loses its detergent properties due to chemical reactions, constant heat, and pollutants. The oil can then actually become harmful to the engine. Thus, one can see the need for keeping oil as clean as possible by changing it frequently.

Two-Stroke Engines

Since the two-stroke engine uses its crankcase to compress the air/fuel mixture so that it can be forced up into the combustion chamber, it cannot also be used as an oil sump. The oil would be splashed around and forced up into the combustion chamber, resulting in the loss of great amounts of lubricating oil while at the same time "contaminating" the air/fuel mixture. In fact the air/fuel mixture would be so filled with oil that it would not ignite.

A two stroke engine is lubricated by mixing the lubricating oil in with the fuel. A mixture of fuel and lubricating oil is sucked into the crankcase and, while it is being compressed by the downward movement of the piston, enough oil attaches itself to the moving parts of the engine to sufficiently lubricate the engine. The rest of the oil is burned along with the fuel/air mixture. As can well be imagined, the mixture ratio of fuel and oil is critical to a two stroke engine. Too much oil will foul the spark plug and too little oil will not lubricate the engine sufficiently, causing excessive wear and possibly engine seizure. Follow the manufacturer's recommendations closely. Most



Lubrication of a two-stroke engine

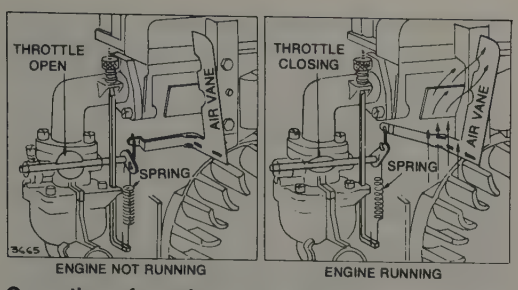
recommend that detergent oils not be used in two stroke engines.

GOVERNORS

The governor is a control that opens and closes the engine throttle to maintain its speed when the load on the engine changes. Consider an engine which is operating a generator. The generator must operate within a very narrow speed range in order to provide the stable output current electrical appliances require. Yet, as appliances in the circuit are turned on and off, the load on the generator changes, which tends to either allow the engine to speed up or force it to slow down.

The governor measures engine speed and responds accordingly. As the speed drops, the throttle is opened. As speed increases the throttle is closed. The governor has a "speed droop," which means that it does not try to keep the engine at exactly the same speed, but allows a gradual drop in speed as load increases. If a governor has a speed droop of 100 rpm, and is set so that the engine runs at 3,650 rpm with no load, loading the engine will cause the throttle to be opened to about the half-way point at 3,600 rpm, and all the way at 3,550 rpm.

The governor is basically just a spring that pulls the throttle open while some other force, which varies with engine speed, tries to close it. The simplest method of providing the closing force is the air vane. The vane is hinged at the leading edge. When it turns on the hinge, it closes the throttle through a simple wire link. The vane is housed inside the cooling system, directly in the path of cooling air. When engine speed increases, air pressure on the vane increases. At a certain speed, the force on the vane is great enough to overcome the tension of the spring and begin stretching the spring, closing the throttle. The point at which the

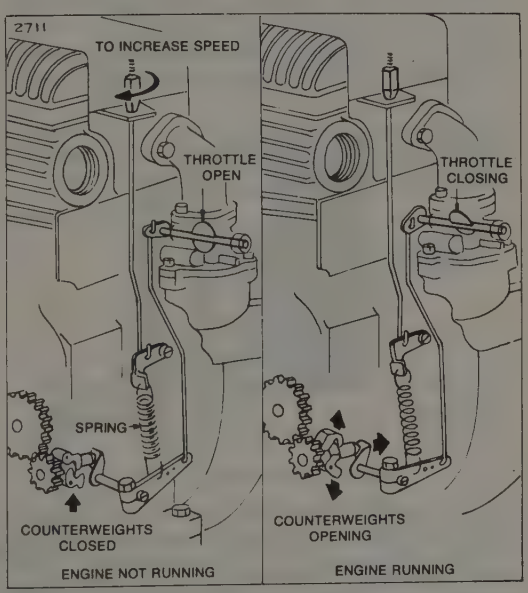


Operation of an air vane governor

spring has stretched enough to nearly close the throttle, and keep the engine speed steady without any load, is somewhat above the point where the vane just begins to stretch the spring. This range is the speed droop. It accounts for the fact that as load is applied to an engine, it finds a slightly lower speed at which it operates.

The flyweight type governor works very similarly. Here, the increasing closing force comes from hinged weights which spin in a circle, driven through gearing from the engine's crankshaft. As engine speed increases, centrifugal force makes the weights turn outward on their hinges and force the throttle closed via a collar which the bottoms of the weights work against.

The spring and flyweights or wind vane are connected via a lever which contains various holes in which the end of the spring can be installed. If the governor is too sensitive (speed droop too small), it will hunt back and forth, causing the throttle to jump violently from full open to idle position and back. If the governor is not sensitive enough (speed droop too great),



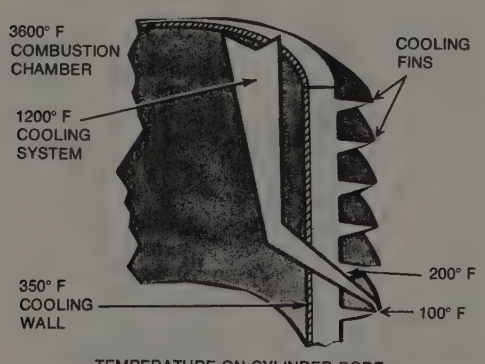
Operation of a flyweight governor

the engine will slow excessively before it adjusts to the load. The spring is moved from hole to hole in order to change this sensitivity. If the spring is hooked near the shaft the lever turns on, a small change in force from the flyweights or air vane will stretch the spring a great deal, making the governor very sensitive. If the spring is hooked to a hole farther away from the pivot point of the lever, a large change in engine speed will be required to stretch it, making the governor slow to respond. The governor speed setting is changed by simply stretching the spring—pulling the end opposite the point where it fits into the lever away from the lever, utilizing any of various kinds of mechanical linkages.

COOLING SYSTEMS

Most small engines are cooled directly by the outside air because this type of system is much less expensive to manufacture, is more easily maintained and repaired, and, if the engine is operating correctly, is more reliable. This type of cooling also saves engine weight, and this is an important side benefit, as many small engines are used to operate hand carried or hand propelled machinery.

Air is a much less efficient coolant than water. It carries much less heat, so that a given volume of air will rise to a very high temperature without actually carrying away very much heat. And, it readily forms stagnant areas around solid objects. Water carries a lot of heat without much temperature rise; it grips tightly to whatever metal object it is cooling, and can easily be kept in uniform motion. For these reasons, air cooled engines are not as tolerant of inefficient, heat producing operation. They must be kept running at peak efficiency if maximum component life is to be realized.



The illustration shows how, as the one-third of energy handled by the engine passes through the cylinder walls and fins, the temperature of the metal drops from 350°F on the cylinder wall to only 100°F at the tips of the fins

The biggest key to making air cooling work is finning. The parts of the cylinder and cylinder head which are exposed to burning gases inside are cast in such a way as to very greatly increase the metal surface exposed to air. At a number of points, the metal of a cylinder, for example, is forced outward from the main structure into a thin sheet or fin that may increase the surface available to air for cooling as much as ten times. While the fins at first might seem to represent excess weight, they actually form an integral portion of the structure of the engine, increasing its rigidity, and decreasing the thickness required in the main structure. While the outer ends of the fins seem to be very far from the source of the heat they in fact carry lots of heat to the cooling air because metal parts are excellent heat conductors, moving energy from hot to cool portions in a process that is a little like the flow of electricity.

Since the air heats fast and can easily become stagnant, forming a blanket near the metal, the second secret of air cooling is high velocity. The air must be guided in a precise manner around every part of the engine coming into contact with the burning fuel. This is done by shrouding the outer edges of the fins where necessary with light metal ducts. Use of a very powerful, centrifugal fan which slings the air outward and through the engine (or draws the air through the engine at high speed) ensures that there will be enough air moving along all the hot parts to break up any stagnant pockets and prevent any of the air from being there long enough to reach excessively high temperatures.

Since air cooling is more sensitive than conventional water cooling systems, always observe the following precautions when operating any air-cooled engine:

1. You have to have a sharper eye with air cooled engines. Watch for sluggish operation and excessive oil consumption that may mean things are getting too hot.
2. Never overload the engine. If the engine runs full throttle below governed rpm, it will be running short of cooling air, and will usually overheat.
3. Use oil of the proper viscosity. Too low a viscosity (or even very dirty oil) will cause excess friction and overheating.
4. Keep all cooling system ducts, shrouds, or seals in top shape—replace any that become loose or even dented. Replace parts whose fins are broken off.
5. Keep fins clean of dust, oil and debris.
6. Keep the cooling air blower clean, and

watch carefully for even partial clogging of the air intake screen. If any of the blower's blades break off, replace the blower or flywheel.

7. Some air cooled engines use thermostatically or throttle controlled air vane to restrict cooling air at low temperatures or under light loads; make sure it works freely and opens when it's supposed to.

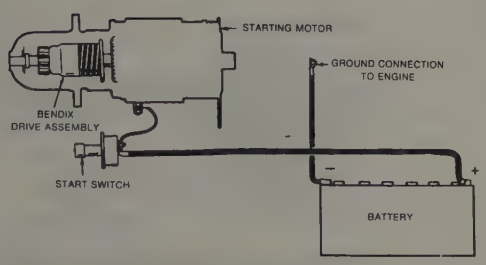
8. Keep the engine in good tune. Lean fuel mixtures, late ignition timing, engine knock, or any other combustion problem will severely overheat the engine.

STARTING SYSTEMS

Electric Starters

Many small engines utilize direct current electric motors for starting purposes. These are run off a standard battery, and the entire system is quite similar to ordinary automotive equipment of this type, except for its smaller size. Direct current motors consist of a stationary coil of wire which is mounted on the inside of the housing, and a rotating coil, which is mounted on the shaft, and is surrounded by the "stator," or stationary coil. Direct current from the battery passes through both coils in series, being carried to the "armature" or rotating coil through brushes. The brushes are mounted inside the housing and rub against commutator rings, which spin with the rotor shaft. The brushes are sprung against the rings so they stay in constant contact. The most common problems with these motors occur when the brushes wear and lose their spring tension.

Some starter motors turn the engine over by engaging a pinion—a gear on the end of the shaft—with a toothed flywheel. Some starter pinions are moved forward into mesh with the flywheel through the action of a magnetic solenoid, while others employ the Bendix drive. The Bendix type pinion spins forward, against



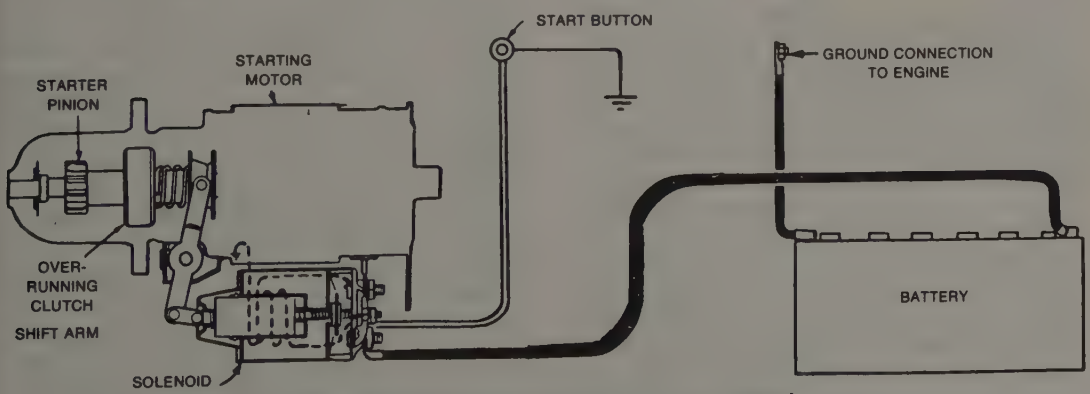
Electric starter with Bendix type engagement

the tension of a spring, via the action of spiral cut grooves in the armature shaft. When the engine starts, the pinion is spun back toward the starter, and then held by the spring. In the solenoid design, an overrunning clutch allows the pinion to spin faster than the starter armature, thus keeping the engine from overspeeding it as it starts. When operating engines with this type of drive, allow the starter to disengage as soon as the engine fires to avoid overheating the overrunning clutch. In both types, but especially the Bendix type, poor engagement may result from poor lubrication of the spiral grooves which guide the pinion along the armature shaft.

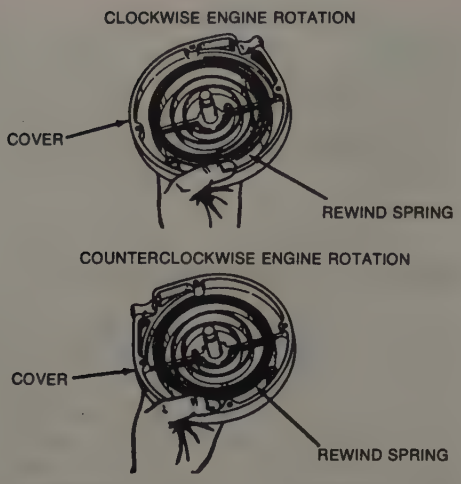
Some electric starters drive through belts and double as generators when the engine starts. This design incorporates a relay that switches the polarity (direction of current flow) through the unit when the engine comes up to speed. Because of the large amount of torque required to turn the engine over, it is important to keep the drive belt under proper tension, and to replace it if it becomes glazed (which can cause it to slip).

Recoil Starters

Recoil starters employ a rope or cable wound around a pulley, but automatically rewind the rope when it is released. The rewind force is provided by a large clock type spring which connects the pulley to the engine housing.



Electric starter with solenoid type engagement



The illustration shows how the rewind spring is mounted inside the cover on one popular type of recoil starter

When the rope is pulled, a cam action engages dogs which cause the engine flywheel to turn with the pulley. When the engine starts, its motion disengages the dogs.

When working on recoil starters, it is absolutely necessary to completely release the tension of the spring before disassembling the unit. If spring tension is released suddenly or unexpectedly, the force released is tremendous, and is very likely to cause personal injury.

2

Routine Care, Maintenance, Storage and Operating Precautions

OPERATING PRECAUTIONS

General

1. Before starting the engine, make sure it is *full* of the proper grade of lubricating oil. Some sort of record of the viscosity of the oil in use should be kept so that the proper grade may be added when necessary and the oil may be changed to keep the viscosity in conformance with recommendations for the outside air temperature range that is prevalent. If the engine is run in hot weather with an oil of too low a viscosity in the crankcase, very serious damage can result. The same sort of damage (from overheating) can occur if the oil level is too low. Remember that all engines must consume some oil to run properly and that, even if the engine is in continuous service, it should be stopped every few hours for an oil level check, and the crankcase refilled.

In the case of two-stroke engines, a recommended two-stroke oil must be used, and it must be mixed in the proportions recommended *for that engine* by the manufacturer. If several two-strokes using different fuel mixes are in use at the same location, each fuel container should be marked so that only the mix recommended for each engine is used in it. Do not simply use a pre-mixed batch of fuel—there is no standard mix. Make sure what you're using is in the exact proportion recommended by the manufacturer. Also, fuel and oil must be uniformly mixed. Usually, this is done by filling the container about 25% of the way with gas, pouring in the oil, and then completing the filling job. After this, the container should be shaken vigorously with the cap applied tightly to complete the mixing process. When using fuel that has been setting for several weeks, shake up the can before refilling the engine fuel tank to ensure uniform mixing.

2. Check that all cooling system air inlets are clear before starting the engine, and check occasionally to make sure nothing has clogged the air intake, especially if a screen is used. Check the condition of fins, fan blades, and thermostatic airflow controls as described above in the description of air cooling systems, periodically.

3. Watch the engine during operation to ensure it is running smoothly at governed speed. If operation is sluggish, stop it immediately and check for possible overloading, overheating, or lack of oil or two stroke lubrication. If the engine lacks power and overheats, check fuel air mixture adjustments (especially on two-stroke engines) and ignition timing.

4. Check for exhaust smoke during operation. If the engine smokes, check first for excessive oil consumption. If this is not due to running too hot or with the crankcase too full, the crankcase breather or engine must be repaired. Smoke can also occur due to a very rich mixture. If necessary, service the air cleaner and check for any restrictions in the air intake. Make sure the choke is fully opened if it is a manual design, and that it is opening properly if it is an automatic design. Adjust the carburetor mixture, if necessary. Smoke may also accompany severe engine knock due to very advanced ignition timing. Check the timing if there is knock.

5. Make sure to use only clean, fresh fuel. Fuel can begin deteriorating only a month after it is purchased. Fuel containing water or rust or other dirt should be discarded. Use leaded or unleaded fuel as per manufacturer's recommendations. Make sure the fuel also meets octane requirements.

6. Set the throttle only slightly above idle in starting (unless this conflicts with specific recommendations for starting), and idle the engine for several minutes before putting it to work. This will allow oil to become thin enough to reach all moving parts of the engine before they begin carrying too much load. It's also a

good idea to idle the engine for a minute or two before shutdown, to cool the hottest parts more gradually.

7. Make sure the engine remains tightly mounted, as vibration can severely damage the engine or other parts, or cause potentially dangerous mechanical damage.

Safety Precautions

1. Never refuel the engine unless it is stopped. Hot exhaust system parts or an electrical spark could ignite the fuel. Also, avoid spillage of fuel, especially when the engine is hot. If fuel spills, make sure it is completely removed before starting the engine. Check the engine occasionally for fuel leaks and repair them immediately. Also, keep ignition high tension wiring in top shape. Brittle insulation can crack, causing a spark which could ignite spilled fuel.

2. Keep all sources of ignition away from batteries, especially when they are being rapidly charged or caps are off. When installing jumper cables between batteries, remove caps and place a rag over open vent holes. Make positive connections first (make sure you connect positive to positive); make negative connections by first connecting the cable to the negative side of the good battery, and making the final connection to a bare spot on the frame of the piece of equipment with the dead battery.

3. Be careful not to come in contact with output terminals on an electric generator, which are often located externally. Remember that metal tools are excellent conductors, and that they too must be kept away from electrical terminals. Even if you do not become exposed to electrical shock via tools, they can serve as a conductor and become hot enough to cause serious burns. This can happen if they touch positive and negative terminals of a battery.

Many electric generators are used only in case of a failure in commercial power. In these cases, they are often connected into a circuit through a transfer switch. Remember that the transfer switch is energized even when the generator is not running. Remember, too, that the output terminals of a generator are hot once the generator is running and electrically excited—it does not need to be carrying a load.

4. Make sure that exhaust gases are properly vented. If you are working near an engine which is enclosed, leaks in the exhaust system can prove dangerous even when the bulk of the exhaust is being carried to the outside air.

5. If your small engine is utilized in a marine engine compartment, remember that the compartment must be thoroughly aired out before starting the engine, or explosion of accumulated fumes may result.

6. Remember that many pieces of equipment driven by small engines are too heavy to be safely carried by a single person. Often, even though the total weight may be within reasonable limits, you may stain yourself because of the difficulty of handling the unit's bulk. Get help!

7. Keep the operating area clean. It should be wiped clean of fluids which could catch fire, and kept free of debris which might be drawn into a fan or blower and thrown out at high speed. This, of course, includes removing debris from a lawn which is to be mowed with a rotary mower or blown clean by a rotary blower.

8. When working on any engine driven accessory, disconnect the spark plug wire to avoid possible accidental starting of the motor if it should be turned over.

9. Keep all safety guards tightly in place, and replace them should they become damaged. Always be fully aware of all moving parts and the possibility of coming into contact with them even if guards are in place.

10. Keep governors in good operating condition, and do not reset for a speed higher than the recommendation of the manufacturer of the equipment.

11. Periodically tighten mounting bolts of both the engine and any machinery driven off it, especially that which turns at crankshaft rpm, such as rotary blades.

Hot and Cold Weather Operation

There are a few things that must be done when a small engine is to be operated in hot or cold weather, that is, when temperatures are either below 30°F, or above 75° F.

Hot Weather

In hot weather, do the following:

1. Keep the cooling fins of the engine block clean and free of all obstructions. Remove all dirt, built up oil and grease, flaking paint and grass.

2. Air should be able to flow to and from the engine with no obstructions. Keep all fairing and cover openings free from obstructions.

3. During hot weather service, heavier weight oil should be used in the crankcase. Follow the manufacturer's recommendations as to the heaviest weight oil allowed in the crankcase.

4. Check the oil level each time the fuel tank is filled. An engine will use more oil in extremely hot weather.

5. Check the battery water level more frequently since, in hot weather, the water in the battery will evaporate more quickly.

6. Be on the lookout for vapor lock, which occurs within the carburetor.

7. Use regular grade gasoline rather than premium.

8. Use unleaded gasoline if possible.

9. The most important thing to remember is to keep the engine as clean as possible. Blow it off with compressed air or wash it as often as possible.

CAUTION: *Wash the engine only after it has had sufficient time to cool down to ambient temperatures. Avoid getting water in or even near the carburetor intake opening.*

Cold Weather

1. A lightweight oil should be installed in the crankcase when operating in cold weather. Consult the manufacturer's recommendations.

2. If the engine is filled with summer weight oil, the engine should be moved to a warm (above 60°F) location and allowed to reach ambient temperature before starting. This is because a heavy summer weight oil will be even thicker at cold temperatures. So thick, in fact, that it will be unable to sufficiently lubricate the engine when it is first started and running. Damage could occur due to lack of lubrication.

3. Change the oil only after the engine has been operated long enough for operating temperatures to have been reached. Change the oil while the engine is still hot.

4. Use fresh gasoline. Fill the gas tank daily to prevent the formation of condensation in the tank and fuel lines.

5. Keep the battery in a fully charged condition, since cold weather infringes upon a battery's maximum current output capabilities.

6. If the engine is run only for short periods of time, have the battery charged every so often to ensure maximum power output when it is needed most.

ROUTINE MAINTENANCE

Care of a small engine is divided into the following five categories: lubrication; filter service; tune-up; carburetor overhaul and fuel pump repair/replacement; combustion chamber deposit removal and valve repair; complete overhaul. Routine maintenance consists of the first three categories. These are described below.

Lubrication

This category includes simple replenishment of lost fluids, and, in part, is the responsibility of the operator. Operators must be aware of not only the need to run the engine only when it is adequately lubricated, but of the need to cease operation and perform required maintenance, even if the actual work is done by a mechanic.

Before starting the engine, fill the crankcase and the air cleaner with the proper oil and fill the gasoline tank. Never try to fill the fuel tank of an engine that is running, and if the engine is still hot from running, allow it to cool down before refueling it.

Use a good grade, clean, fresh, lead free or leaded regular grade automotive gasoline. The use of highly leaded gasoline (high octane) should be avoided, as it causes deposits on the valves and valve seats, spark plugs, and the cylinder head, thus shortening engine life.

Any high quality detergent oil having the American Petroleum Institute classification "For Service SC or SD or MS" can be used. Detergent oils keep the engine cleaner by retarding the formation of gum and varnish deposits. Do not use any oil additives. In the summer (above 40°F) use SAE 30 weight oil. If that is not available, use SAE 10W-30 or SAE 10W-40 weight oil. In the winter (under 40°F) use SAE 5W-20 or SAE 5W-30 weight oil. If neither of these is available, use SAE 10W or SAE 10W-30 weight oil. If the engine is operated in ambient temperatures that are below 0°F, use SAE 10W or SAE 10W-30 weight oil diluted 10% with kerosene.

The oil should be changed after each 25 hours of service or engine operation, and more often under dirty or dusty operating conditions, or as the manufacturer specifies. In normal running of any engine, small particles of metal from the cylinder walls, pistons and bearings will gradually work into the oil. Dust particles from the air also get into the oil. If the oil is not changed regularly, these foreign particles cause increased friction and a grinding action which shorten the life of the engine. Fresh oil also assists in cooling the engine, for old oil gradually becomes thick and cannot dissipate the heat fast enough. Old oil will also gradually lose its lubricating properties.

In two-stroke engines, lubrication consists of ensuring the engine runs on a mix of fuel and oil which is in the proper proportion, and that the oil used meets the specifications of the manufacturer. Since running a two-stroke engine on straight gasoline or an improper mix is very much like operating a four stroke engine without oil, it must be seen that proper preparation of fuel/oil mix is literally a life and death matter for the engine—failure to provide the proper mix may result in immediate engine failure. Always observe the following points:

1. Use an oil specifically designed for two-

stroke engines, and of the viscosity recommended by the manufacturer. The wrong oil may solidify in many different parts of the engine, may leave ash deposits in the combustion chamber, or foul the spark plug. Don't forget that the oil must not only lubricate well, but burn well.

2. Measure the oil accurately into the fuel container in the exact proportion recommended. Mix thoroughly according to the directions on the can (see "Two-Stroke Lubrication" above). Do not simply use a standard, pre-mixed fuel unless you can determine that it is in the correct proportion. Where engines requiring different mixes are used at a common site, label fuel cans with the fuel/oil mixture ratio contained.

3. Remember that available lubrication in a two-stroke also depends on fuel/air ratio. Ensure that carburetors are properly adjusted, and that there are no air leaks so that sufficient lubrication will always be available. Watch, too, for clogged air cleaners, partially closed chokes, or too rich an adjustment, as these will lead to plug fouling. Correct immediately any conditions causing four-cycling or misfire, as gasoline may dilute oil lubing pistons and rings under these conditions.

Filter Service

Air filter service is usually performed at the time of oil change, but may be performed at a longer interval—check specific recommendations. The air cleaner must be serviced much more frequently if the engine is operated in dusty conditions. Check specific recommendations here, also.

Oil type air cleaners require draining of old oil; a thorough cleaning of oil bowl and element with solvent; oiling of the element; and refilling of bowl *to the specified level* with new oil of the type used in the engine.

Most dry element air cleaners require that the element be replaced—they usually cannot be cleaned with compressed air. Some also employ a swirl chamber to remove large dust particles before they reach the main element. This chamber must be thoroughly cleaned out and, in some cases, a dust catching bowl must be emptied and cleaned.

Other types of dry element type air cleaners may require cleaning in soap and water, thorough drying and, in some cases, oiling.

Fuel sediment bowls and strainers, or filters are used on many engines to ensure that the use of dirty fuel or the entrance of dirt into the gas tank will not cause dirt to get into the carburetor. Since only dirt that enters with the fuel or works its way into the tank reaches the filter, it should be obvious that the first step in fuel filter maintenance is the use of clean gas, and the second, proper maintenance of the tank filler cap and gasket. The filter is usually serviced at the same time the oil is changed or at twice that interval. Fuel tank valves are turned off, and the bowl or filter housing is removed and cleaned. Strainers are cleaned in solvent and dried, and pleated paper type elements are replaced.

Oil filters are replaced at every oil change or every other change—consult specific recommendations. Throw-away type filters usually require the use of a strap wrench for ready removal. Wipe the filter base clean, lubricate the seal on the filter with *clean* oil, and tighten only by hand, or the amount specified on the filter. In the case of cartridge type filters, clean the housing with solvent and dry. Make sure to replace seals both at the filter base and around the mounting bolt, as applicable.

Filters deserve the same consistency of attention to recommended service intervals as oil changes. Oil change intervals are determined by the ability of the filter to prolong the life of the oil directly in mind. If the filter is allowed to accumulate dirt to the point where it bypasses due to loss of oil pressure, the oil will be subjected to a much greater than normal amount of material to keep in suspension. This shortens the potential life of the oil drastically, greatly increases the chances of clogging engine oil passages, and may allow abrasive particles large enough to be trapped between moving parts to circulate with the oil. Remember, too, that operation in dusty areas can cause a filter to become clogged and bypassed very quickly. Follow manufacturer's recommendations for more frequent changes under these conditions.

Tune-Up

The following list of procedures is rather extensive for a simple tune-up. Normally one would just check the condition of the spark plug, points, condenser, and wiring, make the necessary adjustments to these components and the carburetor, maybe change the oil, and service the carburetor if needed.

However if the following is performed, you will either be sure that the engine is functioning properly or you will know what major repairs should be made. In other words the engine is going to run well or you will find the cause of any problems.

1. Remove the air cleaner and check for the proper servicing.

2. Check the oil level and drain the crank-

case. Clean the fuel tank and lines if separate from the carburetor.

3. Remove the blower housing and inspect the rope, rewind assembly and starter clutch of the starter mechanism. Thoroughly clean the cooling fins with compressed air, if possible, and check that all control flaps operate freely.

4. Spin the flywheel to check compression. It should be spun in the direction opposite to normal rotation, and as rapidly as possible. A sharp rebound indicates good compression. Four-stroke engines may also be checked with a compression gauge in place of the spark plug—consult manufacturer's specifications in the individual repair section.

5. Remove the carburetor and disassemble and inspect it for wear or damage. Wash it in solvent, replace parts as necessary, and assemble. Set the initial adjustments.

6. Inspect the crossover tube or the intake elbow for damaged gaskets.

7. Check the governor blade, linkage, and spring for damage or wear; if it is mechanical, check the linkage adjustment.

8. Remove the flywheel and check for seal leakage, both on the flywheel and power take off sides. Check the flywheel key for wear and damge.

9. Remove the breaker cover and check for proper sealing.

10. Inspect the breaker points and condenser. Replace or clean and adjust them. Check the plunger or the cam. Lubricate the cam follower.

11. Check the coil and inspect all wires for breaks or damaged insulation. Be sure the lead wires do not touch the flywheel. Check the stop switch and the lead.

12. Replace the breaker cover, using sealer where the wires enter.

13. Install the flywheel and time the ignition if necessary. Set the air gap and check for ignition spark.

14. Remove the cylinder head, check the gasket, remove the spark plug, clean off the carbon, and inspect the valves for proper seating.

15. Replace the cylinder head, using a new gasket, torque it to the proper specification, and set the spark plug gap or replace the plug if necessary.

16. Replace the oil and fuel and check the muffler for restrictions or damage.

17. Adjust the remote control linkage and cable, if used, for correct operation.

18. Service the air cleaner and check the gaskets and element for damage.

19. Run the engine and adjust the idle mixture and high speed mixture of the carburetor.

STORAGE

If an engine is to be out of service for more than 30 days, the following steps should be performed:

1. Run the engine for 5 to 10 minutes until it is thoroughly warmed up to normal operating temperatures.

2. Turn off the fuel supply while the engine is still running, and continue running it until the engine stops from lack of fuel. This procedure removes all fuel from the carburetor.

3. Drain the oil from the crankcase while the engine is still warm.

4. Fill the crankcase with clean oil and tag the engine to indicate what weight oil was installed.

5. Remove the spark plug and squirt about an ounce of oil into the cylinder. Turn the engine over a few times to coat the cylinder walls, the top of the piston, and the head with a protective coating of oil. Reinstall the spark plug and tighten it to the proper torque.

6. Clean or replace the air cleaner. Refer to the manufacturer's recommendations.

7. Clean the governor linkage, making sure that it is in good working order and oiling all joints.

8. Plug the exhaust outlet and the fuel inlet openings. Use clean, lintless rags.

9. Remove the battery and store it in a cool place where there is no danger of freezing. Do not store any wet cell battery directly in contact with the ground or cement floor, as it will establish a ground and discharge itself. A completely discharged battery can never be brought back to its original output capacity. Store the battery on a work bench or on blocks of wood on the floor.

10. Wipe off or wash the engine. Wash only after the engine has had time to cool down to ambient temperature and avoid getting water in the carburetor intake port.

11. Coat all parts that might rust with a light coating of oil. Paint all non-operating parts with a rust inhibiting paint.

12. Provide the entire unit with a suitable covering. Plastic is good where the application and removal of sunlight will not promote the formation of condensation under the plastic covering. If this is the case, use a covering that is able to "breathe," such as a canvas tarpaulin.

3

Troubleshooting the Small Engine

HOW TO GO ABOUT IT

Start with the simplest, most obvious causes first—many engine mechanics and operators have difficulty identifying trouble because they start out assuming everything that is obvious has already been checked. Check to see that there is fuel in the tank, and that it is clean, that the tank is properly vented, and that the fuel filter or sediment bowl is not full of dirt. Check to see that the spark plug wire is connected and that the spark plug is not fouled. If the cause of the trouble is not immediately obvious, use your basic knowledge of how the engine works. For example, if the engine runs fine but is very hard to start, you might conclude that the choke does not close, since its function is confined, mainly, to engine starting.

The guide below will point out many possible causes of the most basic problems. Find the "PROBLEM" which matches the engine's behavior, and then check out the possibilities listed under "CAUSES AND REMEDIES." Refer to the manufacturer's section which pertains to your engine, if necessary, in making repairs.

Troubleshooting Guide

PROBLEM: The engine does not start or is hard to start.

CAUSES AND REMEDIES:

1. The fuel tank is empty.
2. The fuel shut-off valve is closed; open it.
3. The fuel line is clogged. Remove the fuel line and clean it. Clean the carburetor, if necessary.
4. The fuel tank is not vented properly. Check the fuel tank cap vent to see if it is open.
5. There is water in the fuel supply. Drain the tank, clean the fuel lines and the carburetor, and dry the spark plug. Fill the tank with fresh fuel. Check the fuel supply before pouring it into the engine's fuel tank. Chances are it might be the source of the water.
6. The engine is overchoked. Open the choke and throttle wide on manual choke engines. On engines with automatic chokes, close the throttle. Then, turn the engine over with several pulls of the starter rope. If engine does not start, set throttle to just above idle, close choke again, and again attempt to start the engine. If one or two pulls does not make engine fire, try cranking with the choke closed only half way. If engine still fails to start, remove the spark plug and dry it, and spin the engine over several times to clear excess fuel out of the engine. Replace the spark plug and perform the normal starting procedure. Over choking is most often due to *continued cranking* with the choke fully shut.
7. The carburetor is improperly adjusted; adjust it to the standard recommended preliminary settings. See the carburetor section.
8. Magneto wiring is loose or defective. Check the magneto wiring for shorts or grounds and repair it, if necessary.
9. No spark. Check for spark, and if there is none, check and, if necessary, replace the contact points, and set contact gap and timing. If there is still no spark, replace further magneto parts (especially coil and high tension wire) as necessary.
10. The spark plug is fouled. Remove, clean, and regap the spark plug.
11. The spark plug is damaged (cracked procelain, bent electrodes etc.). Replace the spark plug.
12. Compression is poor. The head is loose or the gasket is leaking. Sticking or burned valves or worn piston rings could also be the cause. In any case, the engine will have to be disassembled and the cause of the problem corrected.

PROBLEM: The engine misses under load (if a two-stroke, it may "four-cycle.")
CAUSES AND REMEDIES:
1. The spark plug is fouled. Remove, clean, and regap the spark plug.
2. The spark plug is damaged. Replace the spark plug.
3. The spark plug is improperly gapped. Regap the spark plug to the proper gap.
4. The breaker points are pitted or improperly gapped. Replace the points, or set the gap.
5. The breaker point's breaker arm is sluggish. Clean and lubricate it.
6. The condenser is faulty. Replace it.
7. The carburetor is not adjusted properly. Adjust it.
8. The fuel system is partly clogged, or the fuel shut-off valve is partly closed. Open the valve and check the fuel filter/strainer, tank, lines, and carburetor for dirt. Clean all parts as necessary.
9. If the engine is a two-stroke, the exhaust ports may be clogged. Remove the exhaust manifold and inspect the ports. If they are clogged with carbon, clean them with a soft tool such as a wooden stick. Check also for bad crankshaft seals.
10. The valves are not adjusted properly. Adjust the valve clearance.
11. The valve springs are weak. Replace them.

PROBLEM: The engine knocks.
CAUSES AND REMEDIES:
1. The magneto is not timed correctly. Time the magneto.
2. The carburetor is not properly adjusted (may be too lean). Adjust the carburetor for best mixture.
3. The engine has overheated. Stop the engine and find the cause of overheating.
4. Carbon has built up in the combustion chamber, resulting in retention of excess heat and an increase in compression which causes pre-ignition. Remove the cylinder head, and remove the carbon from the head and the top of the piston.
5. The connecting rod is loose or worn. Replace it.
6. The flywheel is loose. Check the flywheel key and keyway and the end of the crankshaft. Replace any worn parts. Tighten the flywheel nut to the specified torque.
7. The cylinder is worn. Rebuild/replace parts as necessary.

PROBLEM: The engine vibrates excessively.
CAUSES AND REMEDIES:
1. The engine is not mounted securely to the equipment that it operates. Tighten any loose mounting bolts.
2. The equipment that the engine operates is not balanced. Check the equipment.
3. The crankshaft is bent. Replace the crankshaft.
4. The counter balance shaft is improperly timed (recent reassembly) or broken. Disassemble the crankcase, inspect, and replace or repair parts as necessary.

PROBLEM: The engine lacks power.
CAUSES AND REMEDIES:
1. The choke is partially closed. Open the choke.
2. The carburetor is not adjusted correctly. Adjust it.
3. The ignition is not timed correctly. Time the ignition.
4. There is a lack of lubrication or not enough oil in the crankcase. Fill the crankcase to the correct level.
5. The air cleaner is fouled. Clean it.
6. The valves are not sealing. Do a valve job.
7. Ring seal is poor. Repair/replace rings, piston, or cylinder/cylinder liner.
8. If the engine is a two stroke, the exhaust ports may be clogged with carbon. Remove the exhaust manifold and inspect. Clean with a soft instrument such as a wooden stick, if dirty. Ports may clog frequently if the curburetor mixture is adjusted too rich, or if there is excessive oil or oil of the wrong type in the fuel.

PROBLEM: The engine operates erratically, surges, and runs unevenly.
CAUSES AND REMEDIES:
1. The fuel line is clogged. Unclog it.
2. The fuel tank cap vent is clogged. Open the vent hole.
3. There is water in the fuel. Drain the tank, the carburetor, and the fuel lines and refill with fresh gasoline.
4. The fuel pump is faulty. Check the operation of the fuel pump if so equipped.
5. The governor is improperly set or parts are sticking or binding. Set the governor and check for binding parts and correct them.
6. The carburetor is not adjusted properly. Adjust it.

PROBLEM: Engine overheats.
CAUSES AND REMEDIES:
1. The ignition is not timed properly. Time the engine's ignition.
2. The fuel mixture is too lean. Adjust the carburetor.

3. The air intake screen or cooling fins are clogged. Clean away any obstructions.

4. The engine is being operated without the blower housing or shrouds in place. Install the blower housing and shrouds.

5. The engine is operating under an excessive load. Reduce the load and check associated equipment.

6. The oil level is too high. Check the oil level and drain some out if necessary.

7. There is not enough oil in the crankcase. Check the oil level and adjust accordingly.

8. The oil in the crankcase is of too low a viscosity or is excessively contaminated with fuel (four stroke). If the engine is a two-stroke, check for adequate fuel/oil mix—oil must be mixed with the fuel in proper proportions and be fully mixed. Check condition of crankcase oil (four-stroke) and if it appears very dirty, or there is doubt about proper viscosity, replace it.

9. The valve tappet clearance is too close. Adjust the valves to the proper specification.

10. Carbon has built up in the combustion chamber. Remove the cylinder and clean the head and piston of all carbon.

11. An improper amount of oil is mixed with the fuel (two stroke engines only). Drain the fuel tank and fill with correct mixture.

PROBLEM: The crankcase breather is passing oil (four stroke engines only).

CAUSES AND REMEDIES:

1. The crankcase is substantially overfilled with oil. Check oil level several minutes after engine has stopped. Wipe the dipstick clean before checking the level. If the crankcase is too full, drain oil as necessary until oil level is at or slightly below the upper mark.

2. The engine is being operated at too high rpm. Slow it down by adjusting the governor.

3. The oil fill cap or gasket is missing or damaged. Install a new cap and gasket and tighten it securely.

4. The breather mechanism is damaged. Replace the reed plate assembly.

5. The breather mechanism is dirty. Remove, clean, and replace it.

6. The drain hole in the breather is clogged. Clean the breather assembly and open the hole.

7. The piston ring gaps are aligned. Disassemble the engine and offset the ring gaps 90° from each other.

8. The breather is loose or the gaskets are leaking. Tighten the breather to the crankcase.

9. The rings are not seated properly or they are worn. Install new rings.

PROBLEM: The engine backfires.

CAUSES AND REMEDIES:

1. The carburetor is adjusted so the air/fuel mixture is too lean. Adjust the carburetor.

2. The ignition is not timed correctly. Time the engine.

3. The valves are sticking. Do a valve job.

4

Briggs and Stratton

ENGINE IDENTIFICATION

The Briggs and Stratton model designation system consists of up to a six digit number. It is possible to determine most of the important mechanical features of the engine by merely knowing the model number. An explanation of what each number means is given below.

1. The first one or two digits indicate the cubic inch displacement (cid).
2. The first digit after the displacement indicates the basic design series, relating to cylinder construction, ignition and general configuration.
3. The second digit after the displacement indicates the position of the crankshaft and the type of carburetor the engine has.
4. The third digit after the displacement indicates the type of bearings and whether or not the engine is equipped with a reduction gear or auxiliary drive.
5. The last digit indicates the type of starter.

The model identification plate is usually located on the air baffle surrounding the cylinder.

MAINTENANCE

Air Cleaners

A properly serviced air cleaner protects the engine from dust particles that are in the air. When servicing an air cleaner, check the air cleaner mounting and gaskets for worn or damaged mating surfaces. Replace any worn or damaged parts to prevent dirt and dust from entering the engine through openings caused by improper sealing. Straighten or replace any bent mounting studs.

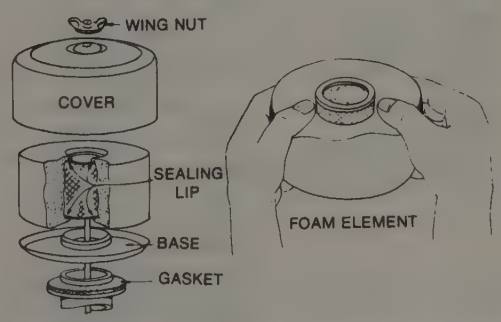
SERVICING

Oil Foam Air Cleaners

Clean and re-oil the air cleaner element every 25 hours of operation under normal operating conditions. The capacity of the oil-foam air cleaner is adequate for a full season's use without cleaning. Under very dusty conditions, clean the air cleaner every few hours of operation.

The oil-foam air cleaner is serviced in the following manner:

1. Remove the screw that holds the halves of the air cleaner shell together and retains it to the carburetor.
2. Remove the air cleaner carefully to prevent dirt from entering the carburetor.
3. Take the air cleaner apart (split the two halves).
4. Wash the foam in kerosene or liquid detergent and water to remove the dirt.
5. Wrap the foam in a clean cloth and squeeze it dry.
6. Saturate the foam in clean engine oil and squeeze it to remove the excess oil.
7. Assemble the air cleaner and fasten it to the carburetor with the attaching screw.



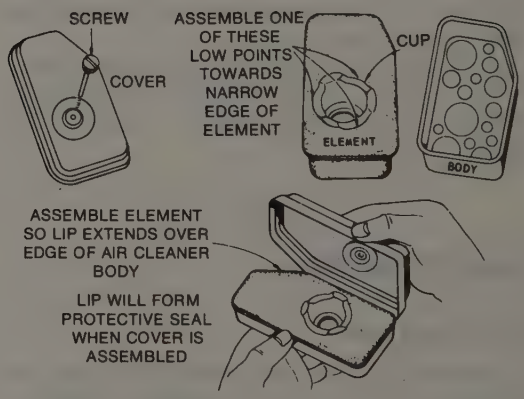
Oil foam air cleaner

Briggs and Stratton Model Numbering System

Cubic Inch Displacement	First Digit After Displacement — Basic Design Series	Second Digit After Displacement — Crankshaft, Carburetor Governor	Third Digit After Displacement — Bearings, Reduction Gears & Auxiliary Drives	Fourth Digit After Displacement — Type of Starter
6	0	0-	0-Plain Bearing	0-Without Starter
8	1	1-Horizontal Vacu-Jet	1-Flange Mounting Plain Bearing	1-Rope Starter
9	2	2-Horizontal Pulsa-Jet	2-Ball Bearing	2-Rewind Starter
10	3	3-Horizontal Flo-Jet (Pneumatic Governor)	3-Flange Mounting Ball Bearing	3-Electric-110 Volt, Gear Drive
13	4	4-Horizontal Flo-Jet (Mechanical Governor)	4-	4-Elec. Starter-Generator-12 Volt, Belt Drive
14	5	5-Vertical Vacu-Jet	5-Gear Reduction (6 to 1)	5-Electric Starter Only-12 Volt, Gear Drive
17	6	6-	6-Gear Reduction (6 to 1) Reverse Rotation	6-Wind-up Starter
19	7	7-Vertical Flo-Jet	7-	7-Electric Starter, 12 Volt Gear Drive, with Alternator
20	8	8-	8-Auxiliary Drive Perpendicular to Crankshaft	8-Vertical-pull Starter
23	9	9-Vertical Pulsa-Jet	9-Auxiliary Drive Parallel to Crankshaft	
24				
30				
32				

General Engine Specifications

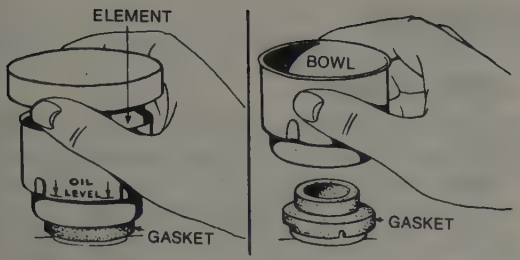
Model	Bore Size (in.)	Horsepower
Aluminum Engines		
6B 60000	2.375	2
8B, 80000, 82000	2.375	3
92000	2.5625	3.5
100000	2.5	4
110000, 111000, 111,200	2.7812	4
130000	2.5625	5
Cast Iron Engines		
5, 6, N	2.000	2
8	2.250	3
9	2.250	3.5
14	2.625	5


SCREW
COVER
ASSEMBLE ONE OF THESE LOW POINTS TOWARDS NARROW EDGE OF ELEMENT
CUP
ELEMENT
BODY
ASSEMBLE ELEMENT SO LIP EXTENDS OVER EDGE OF AIR CLEANER BODY
LIP WILL FORM PROTECTIVE SEAL WHEN COVER IS ASSEMBLED

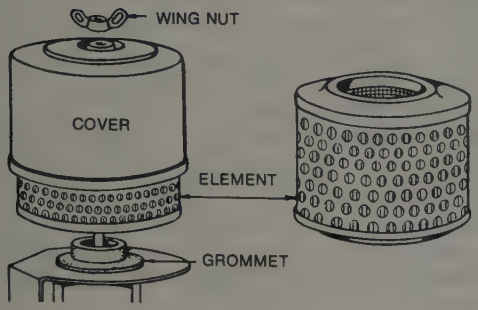
Oil foam air cleaner

Oil Bath Air Cleaner

Pour the old oil out of the bowl. Wash the element thoroughly in solvent and squeeze it dry. Clean the bowl and refill it with the same type of oil used in the crankcase.



Oil bath air cleaner



Dry element air cleaner

Dry Element Air Cleaner

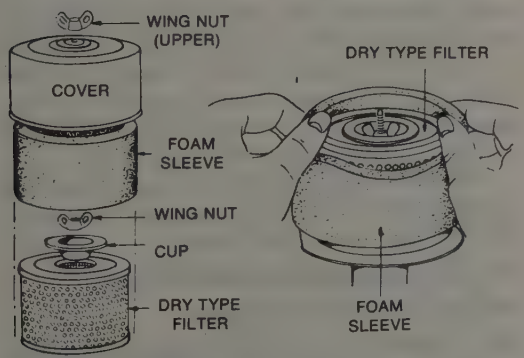
Remove the element of the air cleaner and tap (top and bottom) it on a flat surface or wash it in non-sudsing detergent and flush it from the inside until the water coming out is clear. After washing, air dry the element thoroughly before reinstalling it on the engine. *NEVER OIL A DRY ELEMENT.*

Heavy Duty Air Cleaner

Clean and re-oil the foam pre-cleaner at three month intervals or every 25 hours, whichever comes first.

Clean the paper element every year or 100 hours, whichever comes first. Use the dry element procedure for cleaning the paper element of the heavy duty air cleaner.

Use the oil foam cleaning procedure to clean the foam sleeve of the heavy duty air cleaner.



Briggs and Stratton heavy duty air cleaner

If the engine is operated under very dusty conditions, clean the air cleaner more often.

LUBRICATION

Oil and Fuel Recommendations

Briggs & Stratton recommends either a leaded regular grade gasoline or low-lead or unleaded fuel. Low-lead or unleaded fuel is preferable because of the reduction in deposits that results from its use, but its use is not required. Nor is it necessary to use leaded fuel occasionally in an engine which runs primarily on unleaded fuel, as is the case with some older automobile engines. Premium fuel is not required, as regular or unleaded will have sufficient knock resistance if the engine is in proper condition. The factory recommends that fuel be purchased in lots small enough to be used up in 30 days or less. When fuel is older than that, it can form gum and varnish, or may be improperly tailored to the prevailing temperature.

You should use a high quality detergent oil designated "For Service SC, SD, SE, or MS." Detergent oil is recommended because of its important ability to keep gum and varnish from clogging the lubrication system. Briggs & Stratton specifically recommends that no special oil additives be used.

Oil must be changed every 25 hours of operation. If the atmosphere in which the engine is operating is very dirty, oil changes should be made more frequently, as often as every 12 hours, if necessary. Oil should be changed after 5 hours of operation in the case of brand new engines. Drain engine oil when hot.

In hot weather, when under heavy load, or when brand new, engines may consume oil at a rate which will require you to refill the crankcase several times between oil changes. Check the oil level every hour or so until you

Oil Viscosity Recommendations

Winter (under 40°F.)	Summer (above 40°F.)
SAE 5W-20, or SAE 5W-30	SAE 30
If above are not available:	If above is not available:
SAE 10W or SAE 10W-30 (under 0°F.)	SAE 10W-40 or SAE 10W-30
Use SAE 10W or SAE 10W-30 in proportions of 90% motor oil/ 10% kerosene	

Engine Oil Capacity Chart

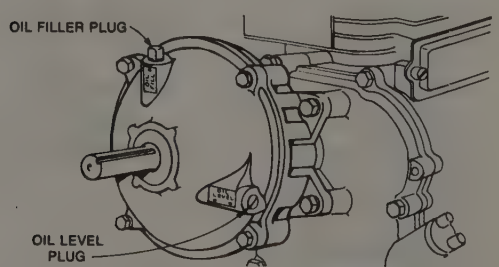
Basic Model Series	Capacity Pints
Aluminum	
6, 8, 9, 11 Cu. in. Vert. Crankshaft	1¼
6, 8, 9 Cu. in. Horiz. Crankshaft	1¼
10, 13 Cu. in. Vert. Crankshaft	1¾
10, 13 Cu. in. Horiz. Crankshaft	1¼
Cast Iron	
9, 14, 19, 20 Cu. in. Horiz. Crank.	3

can accurately estimate how long the engine can go between refills. To check oil level, stop the engine and allow it to sit for a couple of minutes, then remove the dipstick or filler cap. Fill the crankcase to the top of the filler pipe when there is no dipstick, or wipe the dipstick clean, reinsert it, and add oil as necessary until the level reaches the upper mark.

On cast iron engines with a gear reduction unit, crankcase and reduction gears are lubricated by a common oil supply. When draining crankcase, also remove drain plug in reduction unit.

On aluminum engines with reduction gear, a separate oil supply lubricates the gears, although the same type of oil used in the crankcase is used in the reduction gear cover. On these engines, remove the drain plug every fourth oil change (100 hours), then install the plug and refill. The level in the reduction gear cover must be checked during the refill operation by removing the level plug from the side of the gearcase, removing the filler plug, and then filling the case through the filler plug hole until oil runs out the level plug hole. Then, install both plugs.

On 6-1 gear reduction engines (models 6, 8, 8000, 10000, and 13000), no changes are required for the oil in the reduction gear case, but level must be checked and the case refilled, as described in the paragraph above, every 100 hours. Make sure the oil level plug (with screwdriver slot and no vent) is installed in the hole on the *side* of the case.



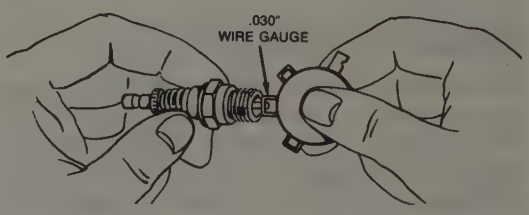
Location of oil fill and level check plugs, 6-1 gear reduction equipped engines

TUNE-UP

Spark Plugs

Remove the spark plug with a ¾" (1½ in. plug) or a $^{13}/_{16}$" (2" plug) deep well socket wrench. Clean carbon deposits off the center and side electrodes with a sharp instrument. If possible, you should also attempt to remove deposits from the recess between the insulator and the threaded portion of the plug. If the electrodes are burned away or the insulator is cracked at any point, replace the plug. Using a wire type feeler gauge, adjust the gap by bending the side electrode where it is curved until the gap is .030 in.

When installing the plug, make sure the threads of the plug and the threads in the cylinder head are clean. It is best to oil the plug threads very lightly. Be careful not to overtorque the plug, especially if the engine has an aluminum head. If you use a torque wrench, torque to about 15 ft. lb.



Checking spark plug gap with a wire feeler gauge

Breaker Points

All Briggs and Stratton engines have magneto ignition systems. Three types are used: Flywheel Type—Internal Breaker Flywheel Type—External Breaker, and Magna-Matic.

FLYWHEEL TYPE—INTERNAL BREAKER

This ignition system has the magneto located on the flywheel and the breaker points located under the flywheel.

The flywheel is located on the crankshaft with a soft metal key. It is held in place by a nut or starter clutch. The flywheel key must be in good condition to insure proper location of the flywheel for ignition timing. Do not use a steel key under any circumstances. Use only a soft metal key, as originally supplied.

The keyway in both flywheel and crankshaft should not be distorted. Flywheels are made of aluminum, zinc, or cast iron.

Flywheel, Nut, and/or Starter Clutch

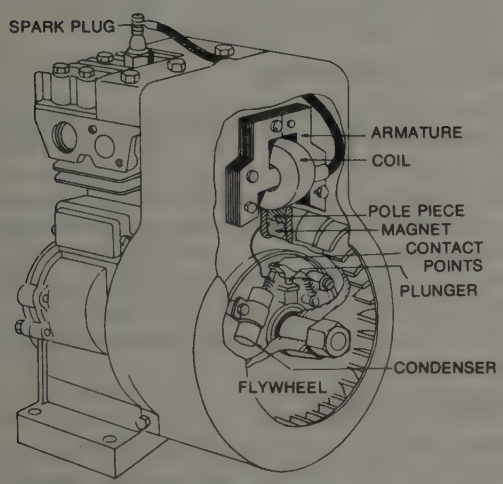
REMOVAL AND INSTALLATION

Place a block of wood under the flywheel fins to prevent the flywheel from turning while you

Tune-Up Specifications

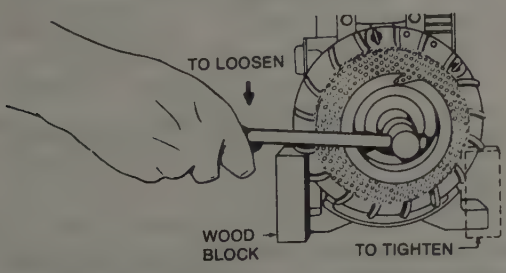
Model	Plug Type	Plug Gap (in.)	Point Gap (in.)	Armature Gap		Idle Speed
				2 leg	3 leg	
Aluminum Block						
6B, 6000, 8B	①	.030	.020	.006–.010	.012–.016	1750
80000, 82000, 92000, 110900	①	.030	.020	.006–.010	.012–.016	1750
100000, 130000	①	.030	.020	.010–.014	.016–.019	1750
Cast Iron Block						
5, 6, N, 8	①	.030	.020	—	.022–.026	1750
9	①	.030	.020	—	—	1200
14	①	.030	.020	—	—	1200

① Manufacturer's Code		Manufacturer
1½ in. plug	2 in. plug	
CJ-8	J-8	Champion
RCJ-8	RJ-8	Champion (resistor)
A-7NX	A-71	Autolite
AR-7N	AR-80	Autolite (resistor)
CS-45	GC-46	A.C.
—	R-46	A.C. (resistor)

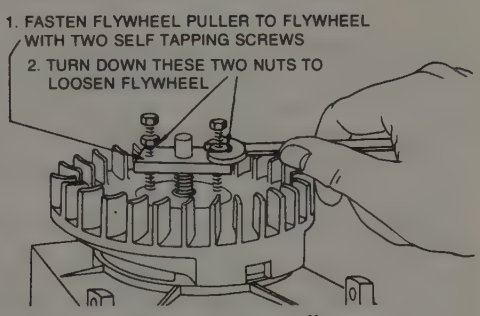


Flywheel magneto ignition with internal breaker points and external armature

are loosening the nut or starter clutch. Be careful not to bend the flywheel. There are special flywheel holders available for this purpose; Briggs & Stratton recommends their use on flywheels of 6¾" diameter or less.



Removing the flywheel



Removing the flywheel with a puller

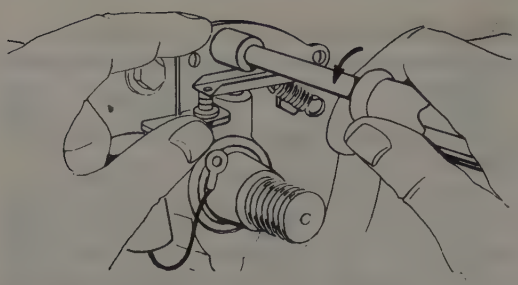
On rope starter engines, the ½ in. flywheel nut has a left-hand thread and the ⅝ in. nut has a right-hand thread. The starter clutch used on rewind or wind-up starters has a right-hand thread.

Some flywheels have two holes provided for the use of a flywheel puller. Use a small gear puller or automotive steering wheel puller to remove the flywheel if a flywheel puller is not available. Be careful not to bend the flywheel if a gear puller is used. On rope starter engines leave the nut on for the puller to bear against. Small cast iron flywheels do not require a puller.

Install the flywheel in the reverse order of removal after inspecting the key and keyway for damage or wear.

Breaker Point Removal and Installation

Remove the breaker cover. Care should be taken when removing the cover, to avoid damaging it. If the cover is bent or damaged,



Removing the breaker point assembly

it should be replaced to insure a proper seal.

The breaker point gap on all models is 0.020 in. Check the points for contact and for signs of burning or pitting. Points that are set too wide will advance the spark timing and may cause kickback when starting. Points that are set too close will retard the spark timing and decrease engine power.

On models that have a separate condenser, the point set is removed by first removing the condenser and armature wires from the breaker point clip. Loosen the adjusting lock screw and remove the breaker point assembly.

On models where the condenser is incorporated with the breaker points, loosen the screw which holds the post. The condenser/point assembly is removed by loosening the screw which holds the condenser clamp.

When installing a point set with the separate condenser, be sure that the small boss on the magneto plate enters the hole in the point bracket. Mount the point set to the magneto plate or the cylinder with a lock screw. Fasten the armature lead wire to the breaker points with the clip and screw. If these lead wires do not have terminals, the bare end of the wires can be inserted into the clip and the screw tightened to make a good connection. Do not let the ends of the wire touch either the point bracket or the magneto plate, or the ignition will be grounded.

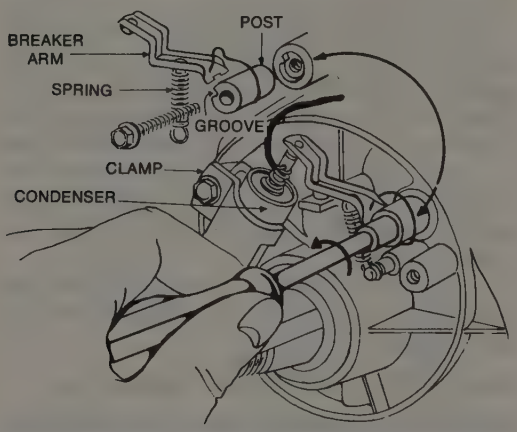
To install the integral condenser/point set, place the mounting post of the breaker arm into the recess in the cylinder so that the groove in the post fits the notch in the recess. Tighten the mounting screw securely. Use a ¼ in. wrench. Slip the open loop of the breaker arm spring through the two holes in the arm, then hook the closed loop of the spring over the small post protruding from the cylinder. Push the flat end of the breaker arm into the groove in the mounting post. This places tension on the spring and pulls the arm against the plunger. If the condenser post is threaded, attach the soil primary wire and the ground wire (if furnished) with the lock washer and nut. If the primary wire is fastened to the condenser with a spring fastener, compress the spring and slip the primary wire and ground wire into the hole in the condenser post. Release the spring. Lay the condenser in place and tighten the condenser clamp securely. Install the spring in the breaker arm.

Point Gap Adjustment

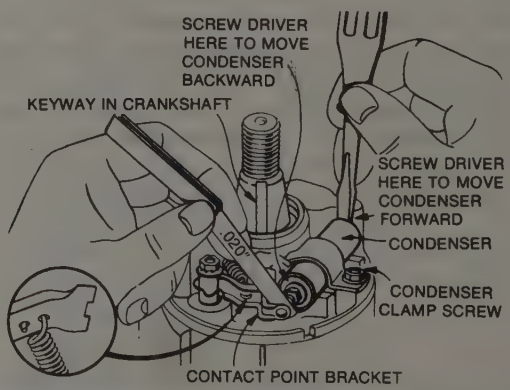
Turn the crankshaft until the points are open to the widest gap. When adjusting a breaker point assembly with an integral condenser, move the condenser forward or backward with a screwdriver until the proper gap is obtained (0.020 in.). Point sets with a separate condenser are adjusted by moving the contact point bracket up and down after the lock screw has been loosened. The point gap is set to 0.020 in.

Breaker Point Plunger

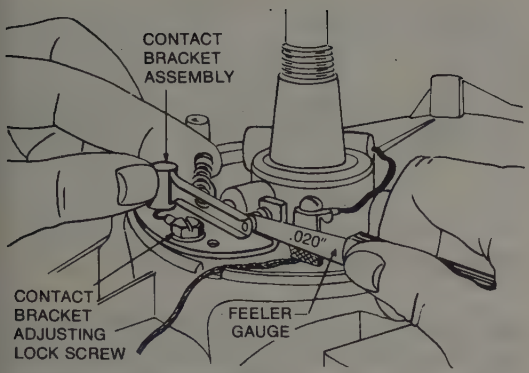
If the breaker point plunger hole becomes excessively worn, oil will leak past the plunger and may get on the points, causing them to



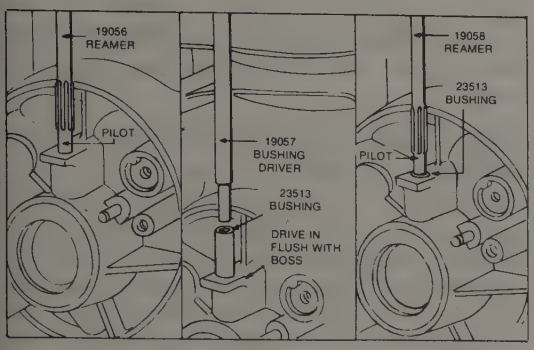
Removing the integral breaker point and condenser assembly



Adjusting point gap on the integral point and condenser assembly



Adjusting the point gap



Replacing the breaker plunger bushing

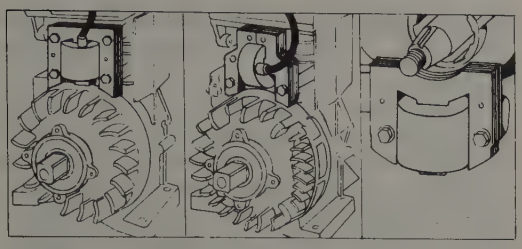
burn. To check the hole, loosen the breaker point mounting screw and move the breaker points out of the way. Remove the plunger. If the flat end of the #19055 plug gauge will enter the plunger hole for a distance of ¼ in. or more, the hole should be rebushed.

To install the bushing, it is necessary that the breaker points, armature, and crankshaft be removed. Use a #19056 reamer to ream out the old plunger hole. This should be done by hand. The reamer must be in alignment with the plunger hole. Drive the bushing, #23513, into the hole until the upper end of the bushing is flush with the top of the boss. Remove all metal chips and dirt from the engine.

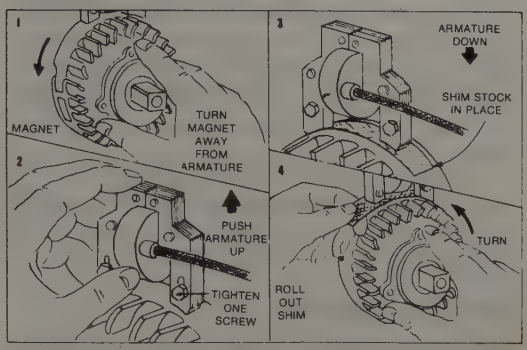
If the breaker point plunger is worn to a length of 0.870 in. or less, it should be replaced. Plungers must be inserted with the groove at the top or oil will enter the breaker box. Insert the plunger into the hole in the cylinder.

Armature Air Gap Adjustment

Set the air gap between the flywheel and the armature as follows: With the armature up as far as possible and just one screw tightened, slip the proper gauge between the armature and flywheel. Turn the fly-wheel until the magnets are directly below the armature.



Variations in armature positioning



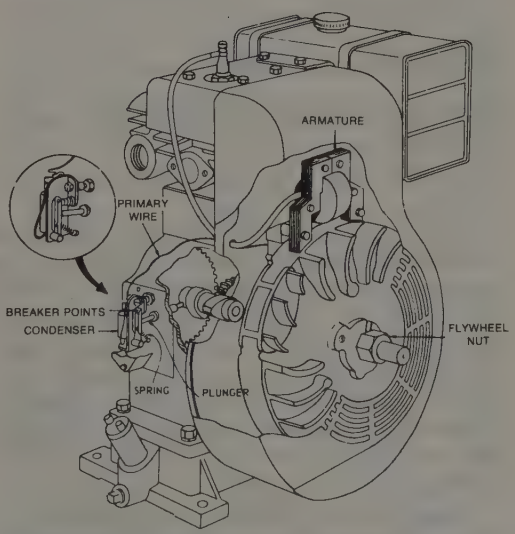
Adjustment of the armature gap

Loosen the one mounting screw and the magnets should pull the armature down firmly against the thickness gauge. Tighten the mounting screws.

FLYWHEEL TYPE—EXTERNAL BREAKER

Breaker Point Set Removal and Installation

Turn the crankshaft until the points open to their widest gap. This makes it easier to assemble and adjust the points later if the crankshaft is not removed. Remove the condenser and upper and lower mounting screws. Loosen



Flywheel magneto ignition with an external breaker assembly

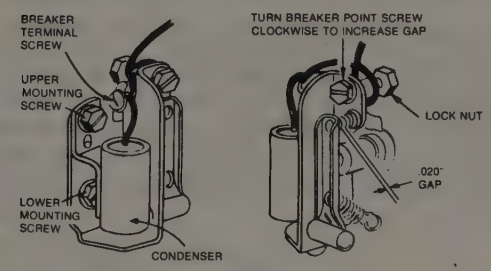
the lock nut and back off the breaker point screw. Install the points in the reverse order of removal.

To avoid the possibility of oil leaking past the breaker point plunger or moisture entering the crankcase between the plunger and the bushing, a plunger seal is installed on the engine models using this type of ignition system. To install a new seal on the plunger, remove the breaker point assembly and condenser. Remove the retainer and eyelet, remove the old seal, and install the new one. Use extreme care when installing the seal on the plunger to avoid damaging the seal. Replace the eyelet and retainer and replace the points and condenser.

NOTE: *Apply a small amount of sealer to the threads of both mounting screws and the adjustment screw. The sealer prevents oil from leaking into the breaker point area.*

Point Gap Adjustment

Turn the crankshaft until the points open to their widest gap. Turn the breaker point adjusting screw until the points open to 0.020 in. and tighten the lock nut. When the cover is installed, seal the point where the primary wire passes under the cover. This area must be resealed to prevent the entry of dust and moisture.



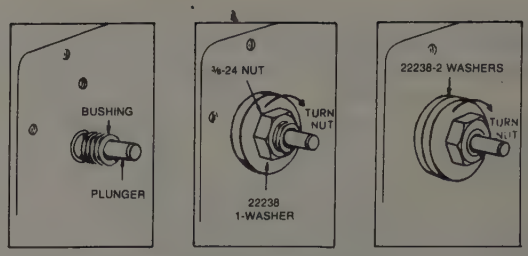
Breaker point gap adjustment

Replacing Threaded Breaker Plunger and Bushing

Remove the breaker cover and the condenser and breaker point assembly.

Place a thick ⅜ in. inside diameter washer over the end of the bushing and screw on the ⅜-24 nut. Tighten the nut to pull the bushing out of the hole. After the bushing has been moved about ⅛ in., remove the nut and put on a second thick washer and repeat the procedure. A total stack of ⅜ in. washers will be required to completely remove the bushing. Be sure the plunger does not fall out of the bushing as it is removed.

Place the new plunger in the bushing with the large end of the plunger opposite the threads on the bushing. Screw the ⅜-24 in.



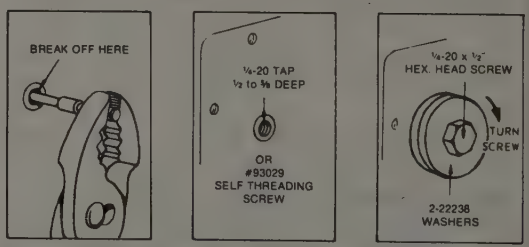
Removing a threaded plunger bushing

nut onto the threads to protect them and insert the bushing into the cylinder. Place a piece of tubing the same diameter as the nut and, using a hammer, drive the bushing into the cylinder until the square shoulder on the bushing is flush with the face of the cylinder. Check to be sure that the plunger operates freely.

Replacing Unthreaded Breaker Plunger and Bushing

Pull the plunger out as far as possible and use a pair of pliers to break the plunger off as close as possible to the bushing. Use a ¼-20 in. tap or a #93029 self threading screw to thread the hole in the bushing to a depth of about ½–⅝ in. Use a ¼-20x½ in. Hex. head screw and two spacer washers to pull the bushing out of the cylinder. The bushing will be free when it has been extracted 5/16 in. Carefully remove the bushing and the remainder of the broken plunger. Do not allow the plunger or metal chips to drop into the crankcase.

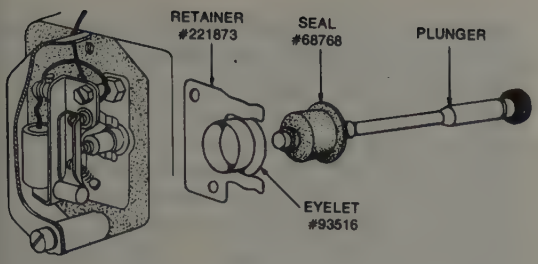
Correctly insert the new plunger into the new bushing. Insert the plunger and the bushing into the cylinder. Use a hammer and the old bushing to drive the new bushing into the cylinder until the new bushing is flush with the face of the cylinder. Make sure that the plunger operates freely.



Removing an unthreaded plunger bushing

Plunger Seal

Later models with Flywheel Type-External Breaker Ignition feature a plunger seal. This seal keeps both oil and moisture from entering the breaker box. If the points have become contaminated on an engine manufactured without this feature, the seal may be installed.



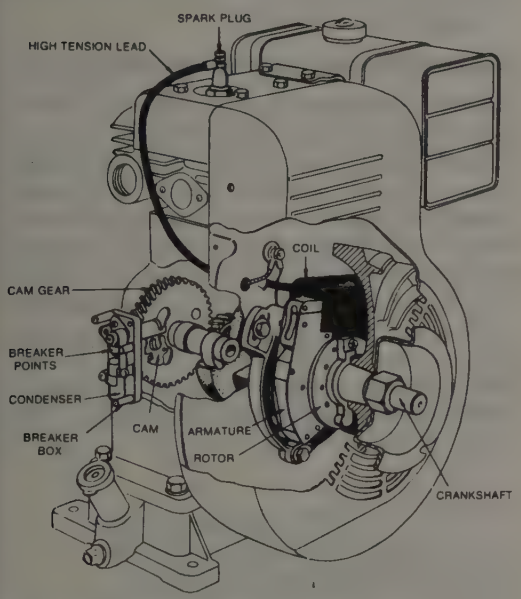
Plunger seal used on later model engines

Parts, part numbers, and their locations are shown in the illustration. Install the seal onto the plunger very carefully to avoid fracturing it.

MAGNA-MATIC IGNITION SYSTEM

Removing the Flywheel

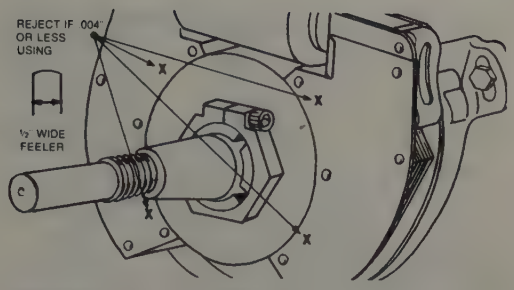
Flywheels on engines with Magna-Matic ignition are removed with pullers similar to factory designs numbered #19068 and 19203. These pullers employ two bolts, which are screwed into holes tapped into the flywheel. The bolts are turned until the flywheel is forced off the crankshaft. Only this type of device should be used to pull these flywheels.



The Magna-Matic ignition system

Armature Air Gap

The armature air gap on engines equipped with Magna-Matic ignition system is fixed and can change only if wear occurs on the crankshaft journal and/or main bearing. Check for wear by inserting a ½ in. wide feeler gauge at several points between the rotor and armature. Minimum feeler gauge thickness is 0.004 in.



Measuring the armature gap

Keep the feeler gauge away from the magnets on the rotor or you will have a false reading.

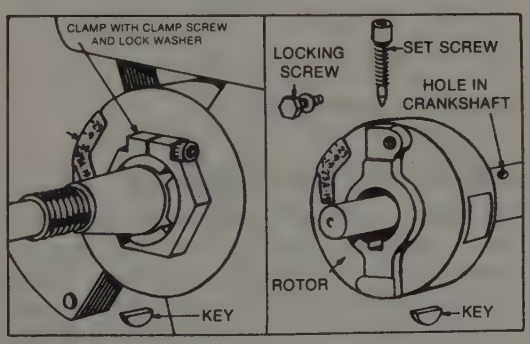
Rotor Removal and Installation

The rotor is held in place by a woodruff key and a clamp on later engines, and a woodruff key and set screw on older engines. The rotor clamp must always remain on the rotor, unless the rotor is in place on the crankshaft and within the armature, or a loss of magnetism will occur.

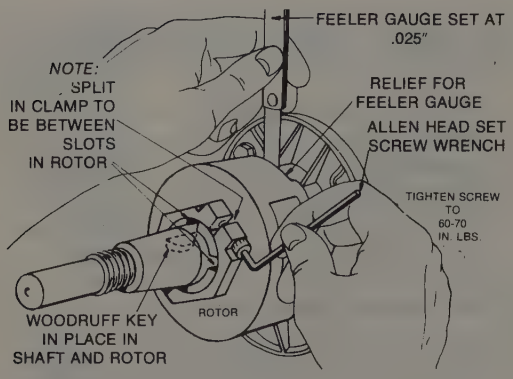
Loosen the socket head screw in the rotor clamp which will allow the clamp to loosen. It may be necessary to use a puller to remove the rotor from the crankshaft. On older models, loosen the small lock screw, then the set screw.

To install the set screw type rotor, place the woodruff key in the keyway on the crankshaft, then slide the rotor onto the crankshaft until the set screw hole in the rotor and the crankshaft are aligned. Be sure the key remains in place. Tighten the set screw securely, then tighten the lock screw to prevent the set screw from loosening. The lock screw is self-threading and the hole does not require tapping.

To install the clamp type rotor, place the woodruff key in place in the crankshaft and align the keyway in the rotor with the woodruff key. If necessary, use a short length of pipe and a hammer to drive the rotor onto the shaft until a 0.025 in. feeler gauge can be inserted between the rotor and the bearing support. The split in the clamp must be between the



Removing the rotor


FEELER GAUGE SET AT .025"
NOTE: SPLIT IN CLAMP TO BE BETWEEN SLOTS IN ROTOR
RELIEF FOR FEELER GAUGE
ALLEN HEAD SET SCREW WRENCH
TIGHTEN SCREW TO 60-70 IN. LBS.
ROTOR
WOODRUFF KEY IN PLACE IN SHAFT AND ROTOR

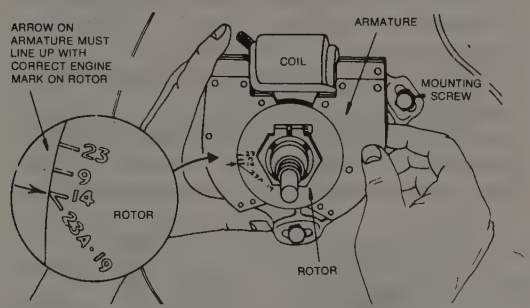
Installing the rotor

slots in the rotor. Tighten the clamp screws to 60 to 70 in. lbs.

Rotor Timing Adjustment

The rotor and armature are correctly timed at the factory and require timing only if the armature has been removed from the engine, or if the cam gear or crankshaft has been replaced.

If it is necessary to adjust the rotor, proceed as follows: with the point gap set at 0.020 in., turn the crankshaft in the normal direction of rotation until the breaker points close and just start to open. Use a timing light or insert a piece of tissue paper between the breaker points to determine when the points begin to open. With the three armature mounting screws slightly loose, rotate the armature until the arrow on the armature lines up with the arrow on the rotor. Align with the corresponding number of engine models, for example, on Model 9, align with #9. Retighten the armature mounting screws.



Adjustment of the timing

Coil and/or Armature Replacement

Usually the coil and armature are not separated, but left assembled for convenience. However, if one or both need replacement, proceed as follows: the coil primary wire and the coil ground wire must be unfastened. Pry out the clips that hold the coil and coil core to the armature. The coil core is a slip fit in the coil and can be pushed out of the coil.

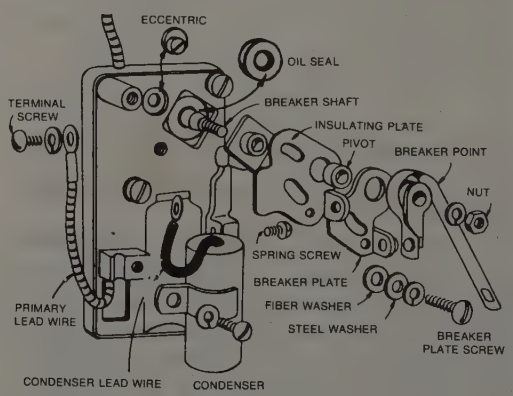
To reassemble, push the coil core into the coil with the rounded side toward the ignition cable. Place the coil and core on the armature with the coil retainer between the coil and the armature and with the rounded side toward the coil. Hook the lower end of the clips into the armature, then press the upper end onto the coil core.

Fasten the coil ground wire (bare double wires) to the armature support. Next, place the assembly against the cylinder and around the rotor and bearing support. Insert the three mounting screws together with the washer and lockwasher into the three long oval holes in the armature. Tighten them enough to hold the armature in place but loose enough so the armature can be moved for adjustment of the timing. Attach the primary wires from the coil and the breaker points to the terminal at the upper side of the backing plate. This terminal is insulated from the backing plate. Push the ignition cable through the louvered hole at the left side of the backing plate.

NOTE: *On Model 9 engines, knot the ignition cable before inserting it through the backing plate. Be sure all wires are clear of the flywheel.*

Breaker Point Removal and Installation

Turn the crankshaft until the points open to the widest gap. This makes it easier to assemble and adjust the points later if the crankshaft is not removed. With the terminal screw out, remove the spring screw. Loosen the breaker shaft nut until the nut is flush with the end of the shaft. Tap the nut to free the breaker arm from the tapered end of the breaker shaft. Remove the nut, lockwasher, and breaker arm. Remove the breaker plate screw, breaker plate, pivot, insulating plate, and eccentric. Pry out the breaker shaft seal with a sharp pointed tool.



The breaker point assembly

To install the breaker points, press in the new oil seal with the metal side out. Put the new breaker plate on the top of the insulating plate, making sure that the detent in the breaker plate engages the hole in the insulating plate. Fasten the breaker plate screw enough to put a light tension on the plate. Adjust the eccentric so that the left edge of the insulating plate is parallel to the edge of the box and tighten the screw. This locates the breaker plate so that the proper gap adjustments may be made. Turn the breaker shaft clockwise as far as possible and hold it in this position. Place the new breaker points on the shaft, then the lockwasher, and tighten the nut down on the lockwasher. Replace the spring screw and terminal screw.

Breaker Box Removal and Installation

Remove the two mounting screws, then remove the breaker box, turning it slightly to clear the arm at the inner end of the breaker shaft. The breaker points need not be removed to remove the breaker box.

To install, pull the primary wire through the hole at the lower left corner of the breaker box. See that the primary wire rests in the groove at the top end of the box, then tighten the two mounting screws to hold the box in place.

Breaker Shaft Removal and Installation

The breaker shaft can be removed, after the breaker points are removed, by turning the shaft one half turn to clear the retaining spur at the inside of the breaker box.

Install by inserting the breaker shaft with the arm upward so the arm will clear the retainer boss. Push the shaft all the way in, then turn the arm downward.

Breaker Point Adjustment

To adjust the breaker points, turn the crankshaft until the breaker points open to the widest gap. Loosen the breaker point plate screw slightly. Rotate the eccentric to obtain a point gap of 0.020 in. Tighten the breaker plate screw.

Mixture Adjustment

920000 ENGINES BUILT SINCE 1968 (AUTOMATIC CHOKE)

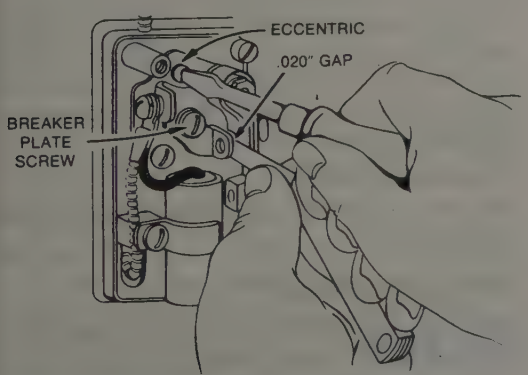
1. Start the engine and run it long enough to reach operating temperature. If the carburetor is so far out of adjustment that it will not start, close the needle valve by turning it clockwise. Then open the needle valve 1½ turns counterclockwise.

2. Move the control so that the engine runs at normal operating speed. Turn the needle valve clockwise until the engine starts to lose speed because of too lean a mixture. Then slowly turn the needle valve counterclockwise and out past the point of smoothest operation until the engine just begins to run unevenly because of too rich a mixture. Turn the needle back clockwise to the midpoint between the rich and lean mixture extremes. This should be where the engine operates smoothest. The final adjustment of the needle valve should be slightly on the rich side (counterclockwise) of the mid-point.

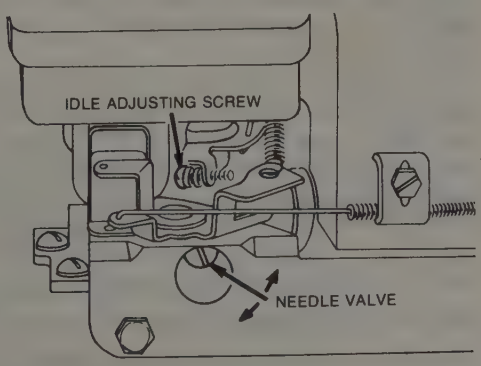
3. Move the engine control to the slow position and turn the idle adjusting screw until a fast idle of about 1750 rpm is obtained. If the engine idles at a speed lower than 1750 rpm, it may not accelerate properly. It is not practical to attempt to obtain acceleration from speeds below 1750 rpm, because the mixture which would be required would be too rich for normal operating speeds.

4. To check the idle adjustment, move the engine control from slow to fast speed. The engine should accelerate smoothly. If the engine tends to stall or die out, increase the idle speed or readjust the carburetor, usually to a slightly richer mixture.

Flooding can occur if the engine is tipped at an angle for a prolonged period of time, if the



Adjusting the breaker point gap



Carburetor adjustment screws

engine is cranked repeatedly with the spark plug wire disconnected, or if the carburetor mixture is too rich.

In case of flooding, move the governor control to the stop position and pull the starter rope at least six times.

When the control is placed in the stop position, the governor spring holds the throttle in a closed idle position. Cranking the engine with a closed throttle creates a higher vacuum which opens the choke rapidly, permitting the engine to clear itself of excess fuel.

Then move the control to the fast position and start the engine. If the engine continues to flood, lean the carburetor needle valve by about ⅛–¼ of a turn clockwise.

PULSA-JET AND VACU-JET (MODEL SERIES 82000, 92000 ONLY)

Models 82500 and 92500 have a Vacu-Jet carburetor and Models 82900 and 92900 have a Pulsa-Jet carburetor.

Adjust the carburetor with the air cleaner installed and the fuel tank half full.

Turn the needle valve clockwise to close it. Then open it about 1½ turns. This will permit the engine to be started and warmed up before making the final adjustment.

With the engine running at normal operating speed (about 3000 rpm without a load) turn the needle valve clockwise until the engine starts to lose speed because of a too lean mixture.

Then slowly turn the needle valve counterclockwise past the point of smoothest operation, until the engine just begins to run unevenly. This mixture will give the best performance under a load.

Hold the throttle in the idle position. Turn the idle speed adjusting screw until a fast idle is obtained (about 1750 rpm).

Test the engine under full load. If the engine tends to stall or die out, it usually indicates that the mixture is slightly lean and it may be necessary to open the needle valve slightly to provide a richer mixture. This slightly richer mixture may cause a slight unevenness in idling.

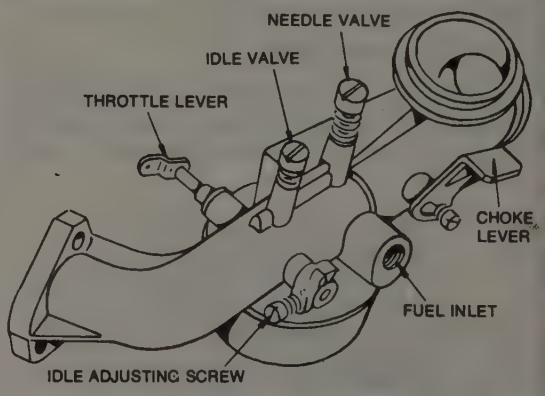
The breather tube and fuel intake tube thread into the cylinder on the model 82500 and 82900 engines. The fuel intake tube is bolted to the cylinder on the model 92500 and 92900 engines. Check for a good fit to prevent any air leaks or dirt entry. The fuel intake tube must not be distorted at the point where the carburetor O-ring fits or air leaks will occur.

TWO PIECE FLO-JET

1. Start the engine and run it at 3,000 rpm until it warms up.
2. Turn the needle valve (flat handle) to both extremes of operation noting the location of the valve at both points. That is, turn the valve inward until the mixture becomes too lean and the engine starts to slow, then note the position of the valve. Turn it outward slowly until the mixture becomes too rich and the engine begins to slow. Turn the valve back inward to the mid-point between the two extremes.
3. Install a tachometer on the engine. Pull the throttle to the idle position and hold it there through the rest of this step. Adjust the idle speed screw until the engine idles at 1,750 rpm if it's an aluminum engine, or 1,200 rpm, if it's a cast iron engine. Then, turn the idle valve in and out to adjust mixture, as described in Step 2. If idle valve adjustment changes idle speed, adjust speed to specification.
4. Release the throttle and observe the engine's response. The engine should accelerate without hesitation. If response is poor, one of the mixture adjustments is too lean. Readjust either or both as necessary. If idle speed was changed after idle valve was adjusted, readjust the idle valve first.

ONE PIECE FLO-JET

Follow the instructions for adjusting the Two Piece Flo-Jet carburetor (above). On the large, One Piece Flo-Jet, the needle valve is located under the float bowl, and the idle valve on top of the venturi passage. On the small One Piece Flo-Jet, both valves are adjusted by screws located on top of the venturi passage. The needle valve is located on the air horn side, is centered above the float bowl, and uses a larger screw head.



Idle valve and needle valve locations on the One Piece Flo-Jet

Governor Adjustments

SETTING MAXIMUM GOVERNED SPEED WITH ROTARY LAWNMOWER BLADES

NOTE: *Strict limits on engine rpm must be observed when setting top governed speed*

on rotary lawnmowers. This is done so that blade tip speeds will be kept to less than 19,000 feet per minute. Briggs & Stratton suggests setting the governor 200 rpm low to allow for possible error in the tachometer reading. These figures below, based on blade length, must be strictly adhered to, or a serious accident could result!

Blade Length (In.)	Max. Governed Speed (R.P.M.)
18	4032
19	3820
20	3629
21	3456
22	3299
23	3155
24	3024
25	2903
26	2791

MODELS N, 6, 8

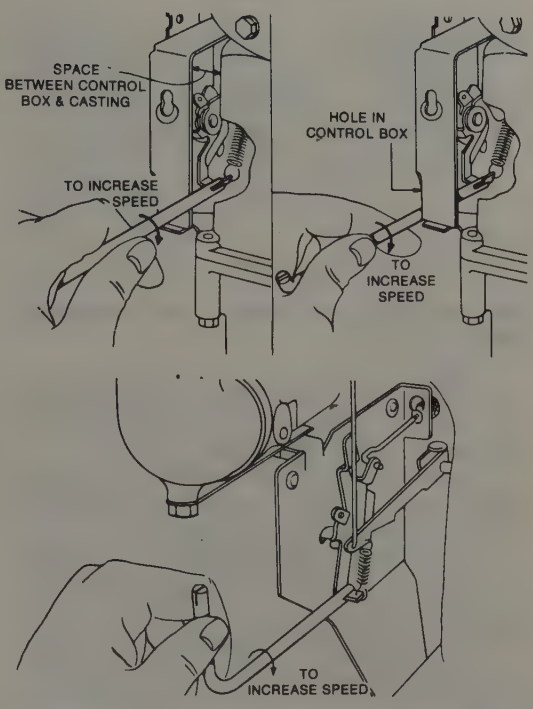
There is no adjustment between the governor lever and the governor crank on these models. However, governor action can be changed by inserting the governor link or spring in different holes of the governor and throttle levers. In general, the closer to the pivot end of the lever, the smaller the difference between load and no-load engine speed. The engine will begin to "hunt" if the spring is brought too close to the pivot point. The farther the spring is from the pivot end, the tendency to hunt will decrease, but the speed drop will be greater as the load increases. If the governor speed is lowered, the spring can usually be moved closer to the pivot. The standard setting is the 4th hole from the pivot point.

MODELS 6B, 8B, 60000, 80000

Loosen the screw which holds the governor lever to the governor shaft. Turn the governor lever counterclockwise until the carburetor throttle is wide open. With a screwdriver, turn the governor shaft counterclockwise as far as it will go. Tighten the screw which holds the governor lever to the governor shaft.

CAST IRON MODELS 9, 14

Loosen the screw which holds the governor lever to the governor shaft. Push the lever counterclockwise as far as it will go. Hold it in position and turn the governor shaft counterclockwise as far as it will go. This can be done with a screwdriver. Securely tighten the screw that holds the governor lever to the shaft.



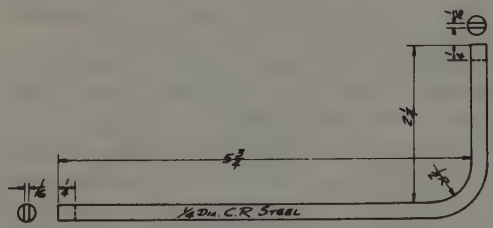
Bending the spring anchor tang to get desired top speed

ALUMINUM MODELS 100000, 130000

Vertical and horizontal shaft engine governors are adjusted by setting the control lever in the high speed position. Loosen the nut on the governor lever. Turn the governor shaft clockwise with a screwdriver to the end of its travel. Tighten the nut. The throttle must be wide open. Check to see if the throttle can be moved from idle to wide open without binding.

Adjusting Top No Load Speed

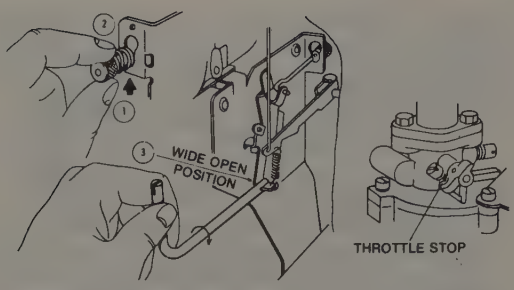
Set the control lever to the maximum speed position with the engine running. Bend the spring anchor tang to get the desired top speed.



You can make a tool like the one shown to adjust spring anchor tang

Adjustment For Closer Governing (Generator Applications Only)

1. Snap knob upward to release adjusting nut.
2. Pull knob out against stop.



Obtaining closer governing on generator applications

3. Then, bend the spring anchor tang to get top no-load speed as described below, depending upon the application.

On models 100200 and 130200 with 3,600 rpm generator, set the no load speed at 4,600 using the standard governor spring.

On models 100200 and 130200 with 1800 rpm generator, set the no load speed at 2,800 rpm, and set throttle stop at 1,600 rpm.

4. Snap knob back into its normal position.

5. Adjust the knob for the desired generator speed.

Choke Adjustment

CHOKE-A-MATIC—PULSA-JET AND VACU-JET CARBURETORS

To check the operation of the choke linkage, move the speed adjustment lever to the choke position. If the choke slide does not fully close, bend the choke link. The speed adjustment lever must make good contact against the top switch.

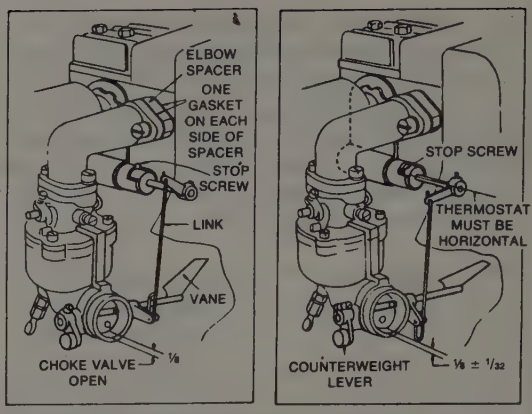
Install the carburetor and adjust it in the same manner as the Pulsa-Jet carburetor.

TWO-PIECE FLO-JET AUTOMATIC CHOKE

Hold the choke shaft so the thermostat lever is free. At room temperature (68°F), the screw in the thermostat collar should be in the center of the stops. If not, loosen the stop screw and adjust the screw.

Loosen the set screw on the lever of the thermostat assembly. Slide the lever to the right or left on the shaft to ensure free movement of the choke link in any position. Rotate the thermostat shaft clockwise until the stop screw strikes the tube. Hold it in position and set the lever on the thermostat shaft so that the choke valve will be held open about ⅛ in. from a closed position. Then tighten the set screw in the lever.

Rotate the thermostat shaft counterclockwise until the stop screw strikes the opposite side of the tube. Then open the choke valve manually until it stops against the top of the choke link opening. The choke valve should



Adjusting automatic choke—Two Piece Flo-Jet

now be open approximately ⅛ in. as before.

Check the position of the counterweight lever. With the choke valve in a wide open position (horizontal) the counterweight lever should also be in a horizontal position with the free end toward the right.

Operate the choke manually to be sure that all parts are free to move without binding or rubbing in any position.

Compression Checking

You can check the compression in any Briggs and Stratton engine by performing the following simple procedure: spin the flywheel counterclockwise (flywheel side) against the compression stroke. A sharp rebound indicates that there is satisfactory compression. A slight or no rebound indicates poor compression.

It has been determined that this test is an accurate indication of compression and is recommended by Briggs and Stratton. Briggs and Stratton does not supply compression pressures.

Loss of compression will usually be the result of one or a combination of the following:

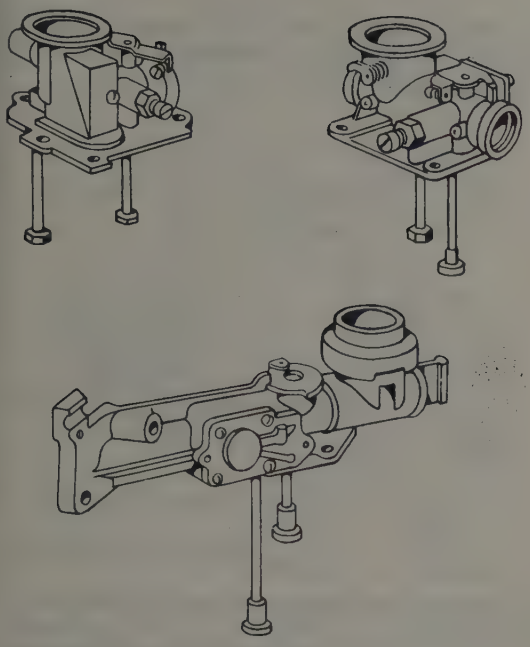
1. The cylinder head gasket is blown or leaking.
2. The valves are sticking or not seating properly.
3. The piston rings are not sealing, which would also cause the engine to consume an excessive amount of oil.

Carbon deposits in the combustion chamber should be removed every 100 or 200 hours of use (more often when run at a steady load), or whenever the cylinder head is removed.

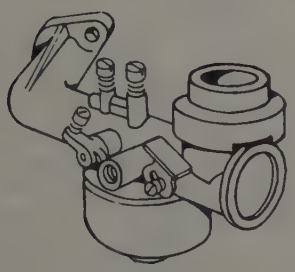
FUEL SYSTEM

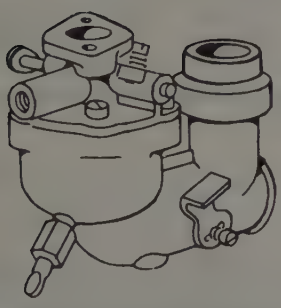
Carburetors

There are three types of carburetors used on Briggs and Stratton engines. They are the



The three types of Pulsa-Jet carburetors



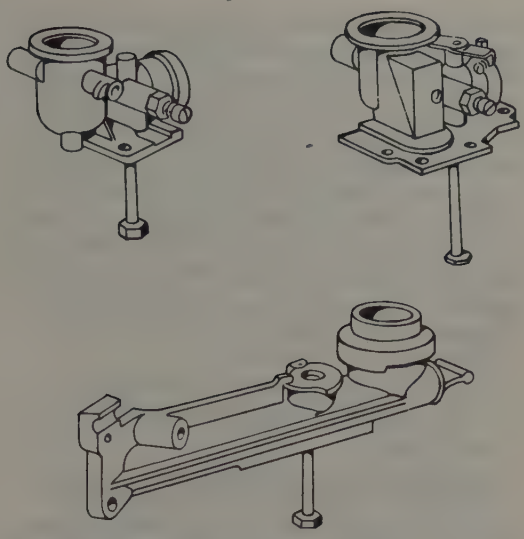


The two types of Flo-Jet carburetors

Pulsa-Jet, Vacu-Jet and Flo-Jet. The first two types have three models each and the Flo-Jet has two versions.

Before removing any carburetor for repair, look for signs of air leakage or mounting gaskets that are loose, have deteriorated, or are otherwise damaged.

Note the position of the governor springs, governor link, remote control, or other attachments to facilitate reassembly. Be careful not to bend the links or stretch the springs.



The three types of Vacu-Jet carburetors

AUTOMATIC CHOKE

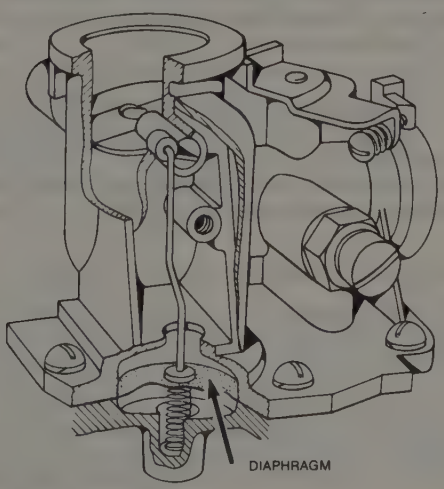
All 92000 model engines built since August 1968 have an automatic choke system.

The automatic choke operates in conjunction with engine vacuum, similar to the Pulsa-Jet fuel pump.

A diaphragm under the carburetor is connected to the choke shaft by a link. A calibrated spring under the diaphragm holds the choke closed when the engine is not running. Upon starting, vacuum created during the intake stroke is routed to the bottom of the diaphragm through a calibrated passage, thereby opening the choke.

This system also has the ability to respond in the same manner as an accelerator pump. As speed decreases during heavy loads, the choke valve partially closes, enriching the air/fuel mixture, thereby improving low speed performance and lugging power.

To check the automatic choke, remove the



Automatic choke system

air cleaner and replace the stud. Observe the position of the choke valve; it should be fully closed. Move the speed control to the stop position; the governor spring should be holding the throttle in a closed position. Give the starter rope several quick pulls. The choke valve should alternately open and close.

If the choke valve does not react as stated in the previous paragraph, the carburetor will have to be disassembled to determine the problem. Before doing so, however, check the following items so you know what to look for:

Engine is under-choked.

1. Carburetor is adjusted too lean.
2. The fuel pipe check valve is inoperative (Vacu-Jet only).
3. The air cleaner stud is bent.
4. The choke shaft is sticking due to dirt.
5. The choke spring is too short or damaged.
6. The diaphragm is not preloaded.

Engine is over-choked.

1. Carburetor is adjusted too rich.
2. The air cleaner stud is bent.
3. The choke shaft is sticking due to dirt.
4. The diaphragm is ruptured.
5. The vacuum passage is restricted.
6. The choke spring is distorted or stretched.
7. There is gasoline or oil in the vacuum chamber.
8. There is a leak between the link and the diaphragm.
9. The diaphragm was folded during assembly, causing a vacuum leak.
10. The machined surface on the tank top is not flat.

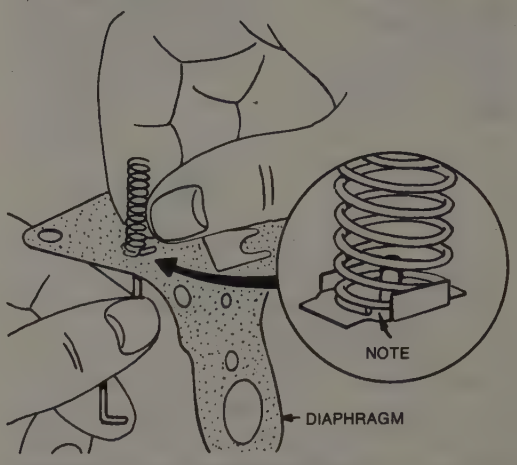
Replacing the Automatic Choke

Inspect the automatic choke for free operation. Any sticking problems should be corrected as proper choke operation depends on freedom of the choke to travel as dictated by engine vacuum.

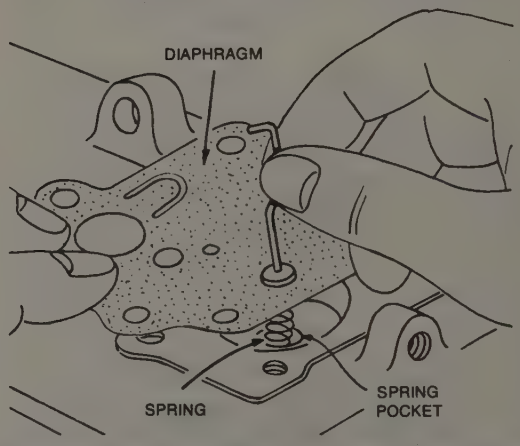
Remove the carburetor and fuel tank assembly from the engine. The choke link cover may now be removed and the choke link disconnected from the choke shaft. Disassemble the carburetor from the tank top, being careful not to damage the diaphragm.

CHECKING THE DIAPHRAGM AND SPRING

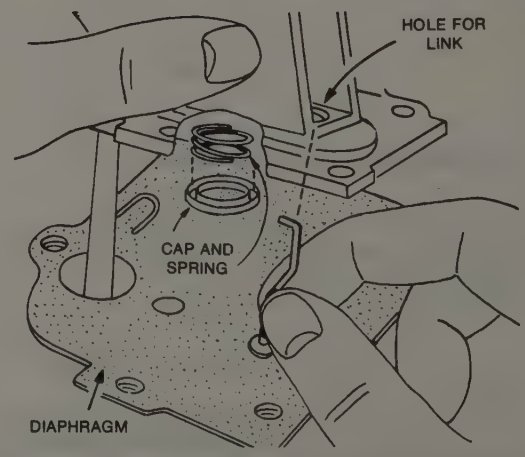
The diaphragm can be reused, provided it has not developed wear spots or punctures. On the Pulsa-Jet models, make sure that the fuel pump valves are not damaged. Also check the choke spring length. The Pulsa-Jet spring minimum length is 1⅛ in. and the maximum is $1^{7}/_{32}$ in. Vacu-Jet spring length minimum is $^{15}/_{16}$ in., maximum length 1 in. If the spring length is shorter or longer than specified, replace the diaphragm and the spring.



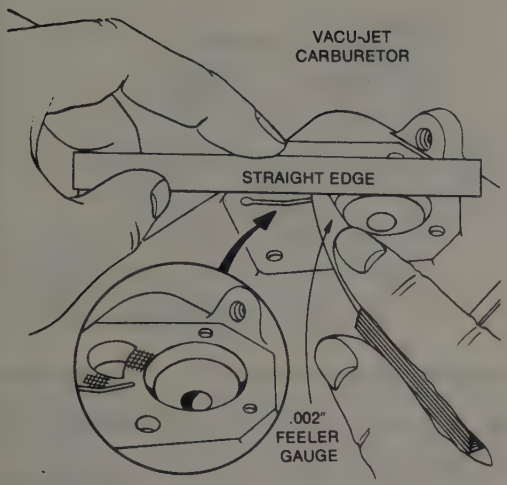
Assembling the diaphragm spring to the new diaphragm



Installing the diaphragm and spring into the spring pocket



Positioning the diaphragm on top of the fuel tank



Checking the tank top for warpage

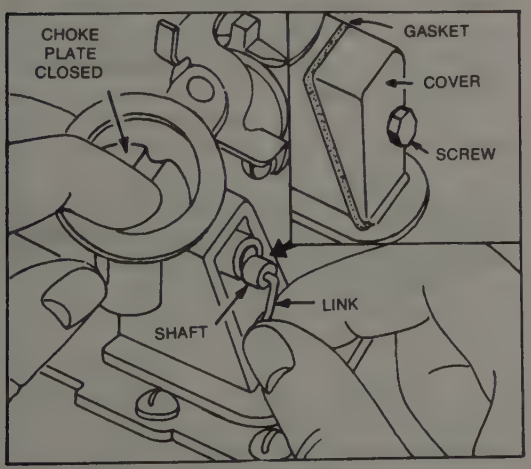
CHECKING THE TANK TOP

The machined surface on the top of the tank must be flat in order for the diaphragm to provide an adequate seal between the carburetor and the tank. If the machined surface on the tank is not flat, it is possible for gasoline to enter the vacuum chamber by passing between the machined surface and the diaphragm. Once fuel has entered the vacuum chamber, it can move through the vacuum passage and into the carburetor. The flatness of the machined surface on the tank top can be checked by using a straightedge and a feeler gauge. The surface should not vary more than 0.002 in. Replace the tank if a 0.002 in. feeler gauge can be passed under the straightedge.

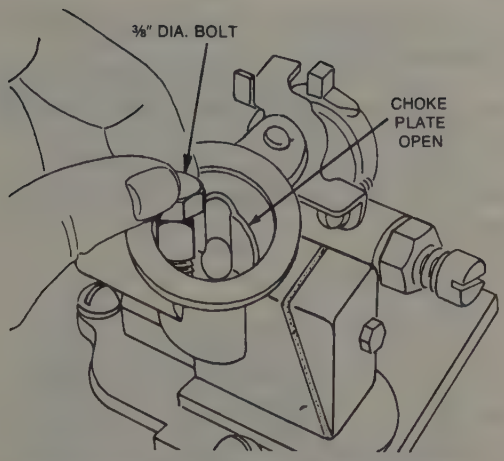
If a new diaphragm is installed, assemble the spring to the replacement diaphragm, taking care not to bend or distort the spring.

Place the diaphragm on the tank surface, positioning the spring in the spring pocket.

Place the carburetor on the diaphragm ensuring that the choke link and diaphragm are properly aligned between the carburetor and the tank top. On Pulsa-Jet models, place the pump spring and cap on the diaphragm over the recess or pump chamber in the fuel tank. Thread in the carburetor mounting screws to about two threads. Do not tighten them. Close the choke valve and insert the choke link into the choke shaft.



Inserting the choke link into the choke shaft



Pre-loading the diaphragm to adjust the choke

Remove the air cleaner gasket, if it is in place, before continuing. Insert a ⅜ in. bolt or rod into the carburetor air horn. With the bolt in position, tighten the carburetor mounting screws in a staggered sequence. Please note that the insertion of the ⅜ in. bolt opens the choke to an over-center position, which preloads the diaphragm.

Remove the ⅜ in. bolt. The choke valve should now move to a fully closed position. If the choke valve is not fully closed, make sure that the choke spring is properly assembled to the diaphragm, and also properly inserted in its pocket in the tank top.

All carburetor adjustments should be made with the air cleaner on the engine. Adjustment is best made with the fuel tank half full. See the "Tune-Up" section.

PULSA-JET AND VACU-JET (MODEL SERIES 82000, 92000 ONLY)

Models 82500 and 92500 have a Vacu-Jet carburetor and Models 82900 and 92900 have a Pulsa-Jet carburetor.

Rebuilding

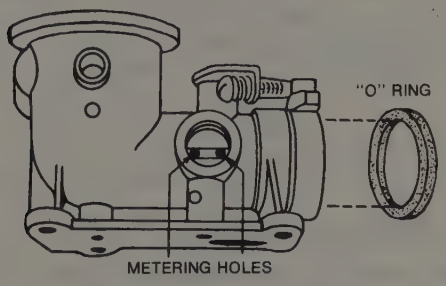
1. Remove the carburetor and fuel tank assembly from the engine by removing the two attaching bolts.

2. Disconnect the governor link at the throttle, leaving the governor link and the governor spring hooked to the governor blade and control lever.

3. Slip the carburetor and tank assembly off of the engine.

4. Remove the carburetor from the tank. Always remove all nylon and rubber parts if the carburetor is soaked in solvent.

5. Remove the O-ring and discard it. Remove and inspect the needle valve, packing and seat.



Remove the O-ring and inspect the metering valve

6. Metering holes in the carburetor body should be cleaned with solvent and compressed air. Do not clean the holes with a pin or a length of wire because of the danger of altering their size.

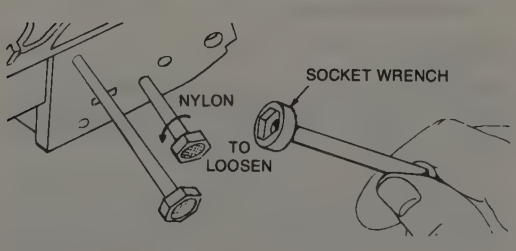
7. Remove the choke parts on models 82500 and 82900 by pulling the nylon choke shaft sideways to separate the choke shaft from the choke valve. On the 92500 and 92900, remove the choke parts by first disconnecting the choke return spring at the pin in the carburetor body. Then pull the nylon choke shaft sideways to separate the choke shaft from the choke valve.

8. If the choke valve is heat-sealed to the choke shaft, loosen it by sliding a sharp pointed tool along the edge of the choke shaft. Do not re-seal parts on assembly.

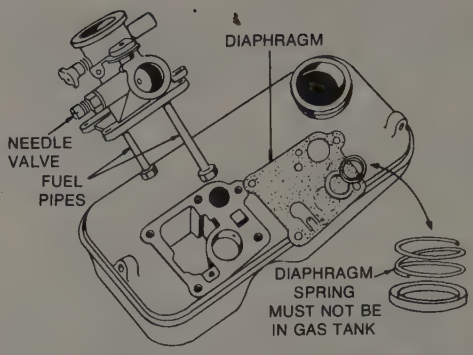
9. When replacing the choke valve and shaft, install the choke valve so the poppet valve spring is visible when the valve is in full choke position.

On these models, the nylon fuel pipe is threaded into the carburetor body. Use a socket to remove and replace it. Be careful not to overtighten it and do not use any sealer.

The Pulsa-Jet diaphragm also serves as a gasket between the carburetor and the tank. Inspect the diaphragm for punctures, wrinkles, and wear. Replace it if it is damaged in any way.



Removing the nylon fuel pipes



Removal and inspection of a Pulsa-Jet diaphragm

To assemble the carburetor to the tank, first position the diaphragm on the tank. Then place the spring cap and spring on the diaphragm. Install the carburetor, tightening the mounting screws evenly to avoid distortion.

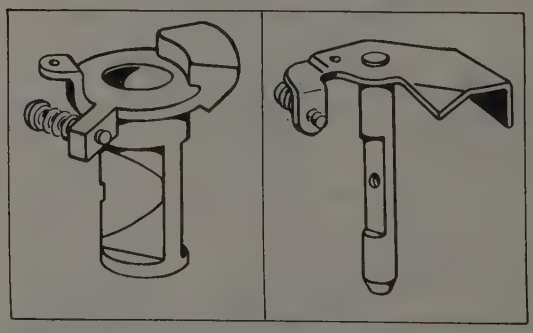
To install the carburetor and tank assembly onto the engine, make sure that the governor link is hooked to the governor blade. Connect the link to the throttle and slip the carburetor into place. Align the carburetor with the intake tube and breather tube grommet. Hold the choke lever in the open position so it does not catch on the control plate. Be sure the O-ring in the carburetor does not distort when fitting the carburetor to the intake tube. Install the mounting bolts. Adjust the carburetor as described in the Tune-Up section.

PULSA-JET CARBURETOR

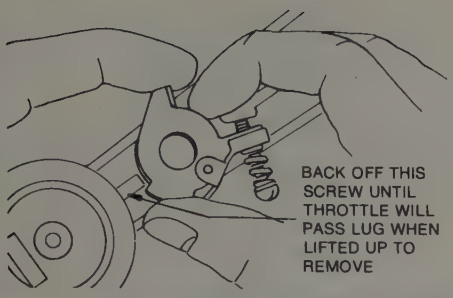
Throttle Plate Removal

Cast throttle plates are removed by backing off the idle speed adjustment screw until the throttle clears the retaining lug on the carburetor housing.

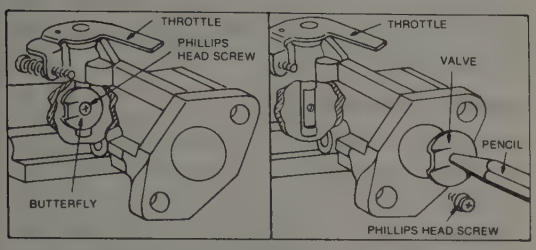
Stamped throttles are removed by using a phillips screwdriver to remove the throttle valve screw. After removal of the valve, the throttle may be lifted out. Installation is the reverse of removal.



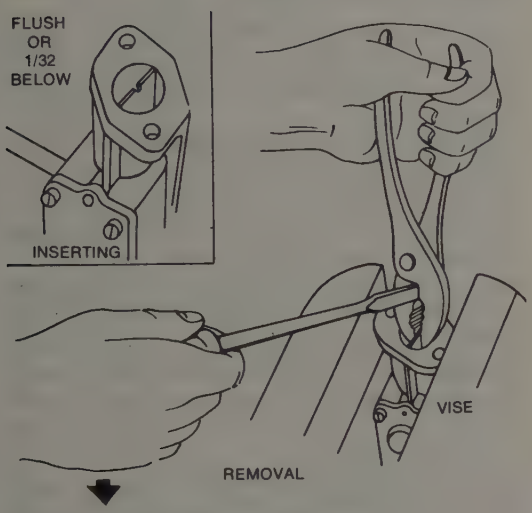
The two types of throttle shafts



Removing the cast throttle shafts



Removing the throttle plate

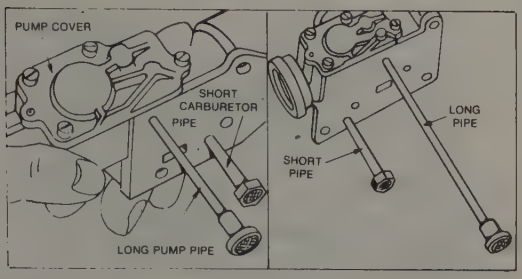


Removing and installing the spiral

Some carburetors may have a spiral in the carburetor bore. To remove it, fasten the carburetor in a vise about ½ in. below the top of the jaws. Grasp the spiral firmly with a pair of pliers. Place a screwdriver under the edge of the pliers. Using the edge of the vise, push down on the screwdriver to pry out the spiral. When installing the spiral, keep the top flush, or 1/32 in. below the carburetor flange, and parallel with the fuel tank mounting face.

Fuel Pipe

Check balls are not used in these fuel pipes. The screen housing or pipe must be replaced if the screen cannot be satisfactorily cleaned. The long pipe supplies fuel from the tank to the pump. The short pipe supplies fuel from the tank cup to the carburetor. Fuel pipes are nylon or brass. Nylon pipes are removed and installed by using a socket, or open-end wrench.



Fuel pipes

NOTE: *Where brass pipes are used, replace only the screen housing. The housing is driven off the piep with a screwdriver with the pipe held in a vise. The new housing is installed by lightly tapping it onto the pipe with a soft hammer.*

Needle Valve and Seat

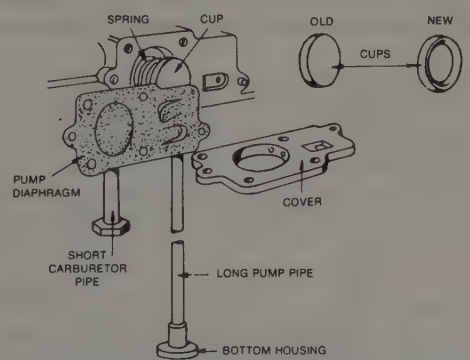
Remove the needle valve to inspect it. If the carburetor is gummy or dirty, remove the seat to allow better cleaning of the metering holes. Do not insert pins or wires in the metering holes. Use solvent or compressed air.

Pump

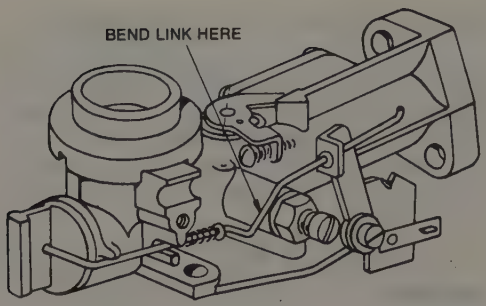
Remove the fuel pump cover, diaphragm, spring, and cup. Inspect the diaphragm for punctures, cracks, and fatigue. Replace it if damaged. On early models, the spring cap is solid; on later models, the cap has a hole in it. The new style supersedes the old style. When installing the pump cover, tighten the screws evenly to insure a good seal.

Choke-A-Matic (Except 100900 Models)

To remove the choke link, remove the speed adjustment lever and stop switch insulator



Removal and inspection of the pump cover diaphragm from a Pulsa-Jet carburetor



Adjustment of the Choke-a-Matic choke linkage

plate. Remove the speed adjustment lever from the choke link, then pull out the choke link through the hole in the choke slide.

Replace worn or damaged parts. To assemble, slip the washers and spring over the choke link. Hook the choke link through the hole in the choke slide. Place the other end of the choke link through the hole in the speed adjustment lever and mount the lever and stop switch insulator plate to the carburetor.

VACU-JET CARBURETORS

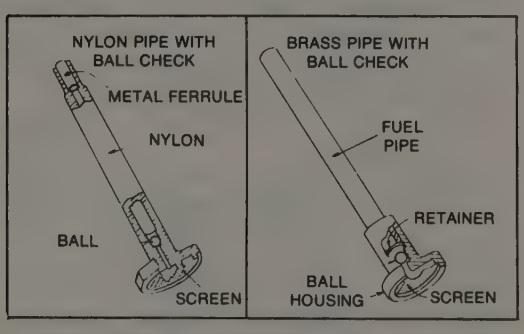
Vacu-Jet carburetors are removed from the engine together with the fuel tank as one unit. The throttle plates are removed and installed in the same manner as the throttles in the Pulsa-Jet carburetors.

Fuel Pipe

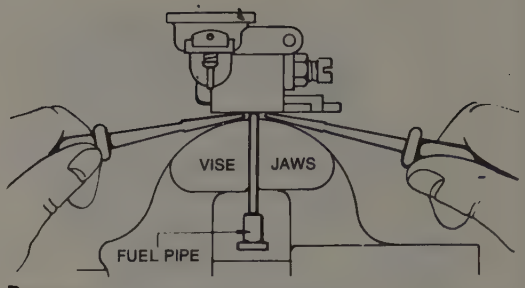
The fuel pipe contains a check ball and a fine mesh screen. To function properly, the screen must be clean and the check ball free. Replace the pipe if the screen and ball cannot be satisfactorily cleaned in carburetor cleaner.

NOTE: *Do not leave the carburetor in the cleaner for more than ½ hour without removing all nylon parts. Nylon fuel pipes are removed and replaced with a $^{9}/_{16}$ in. socket. Brass fuel pipes are removed by clamping the pipe in a vise and prying out the pipe with two screwdrivers.*

To install the brass fuel pipes, remove the throttle, if necessary, and place the carburetor



The two types of fuel pipes



Removal of brass fuel pipes

and pipe in a vise. Press the pipe into the carburetor until it projects $2^{9}/_{32}$–$2^{5}/_{16}$ in. from the carburetor face.

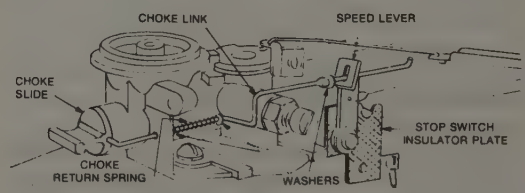
Needle Valve and Seat

Remove the needle valve assembly to inspect it. If the carburetor is gummy or dirty, remove the seat to allow better cleaning of the metering holes. Do not clean the metering holes with a pin or a length of wire.

Choke-A-Matic Linkage

To remove the choke link, remove the speed adjustment lever and the top switch insulator plate. Work the link out through the hole in the choke slide.

Replace all worn or damaged parts. To assemble a carburetor using a choke slide, place the choke return spring and three washers on the choke link. Push the choke link through the hole in the carburetor body, turning the link to line up with the hole in the choke slide. The speed adjustment lever screw and the stop switch insulator plate should be installed as one assembly after placing the choke link through the end of the speed adjustment lever.

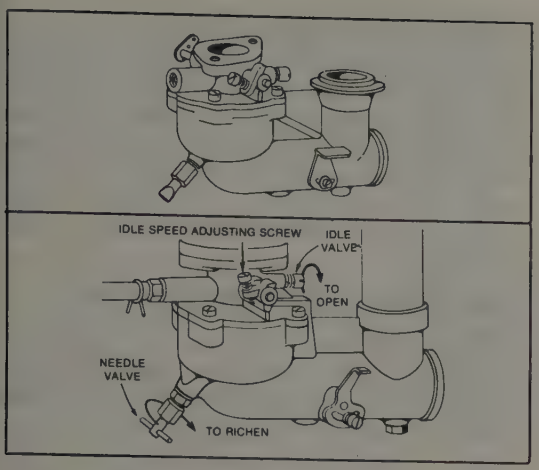


Adjustment of a Choke-a-Matic choke linkage on a Vacu-Jet carburetor

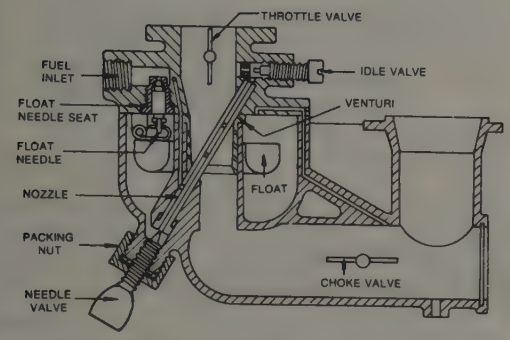
TWO PIECE FLO-JET CARBURETORS (LARGE AND SMALL LINE)

Checking the Upper Body for Warpage

With the carburetor assembled and the body gasket in place, try to insert a 0.002 in. feeler gauge between the upper and lower bodies at the air vent boss, just below the idle valve. If the gauge can be inserted, the upper body is warped and should be replaced.



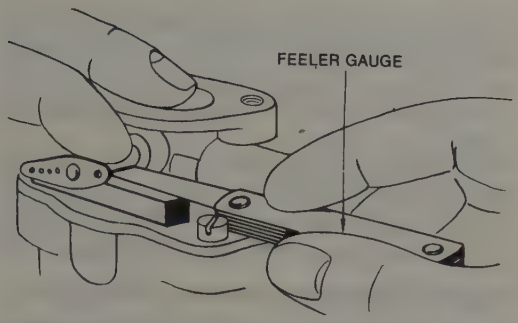
Two piece Flo-Jet carburetor



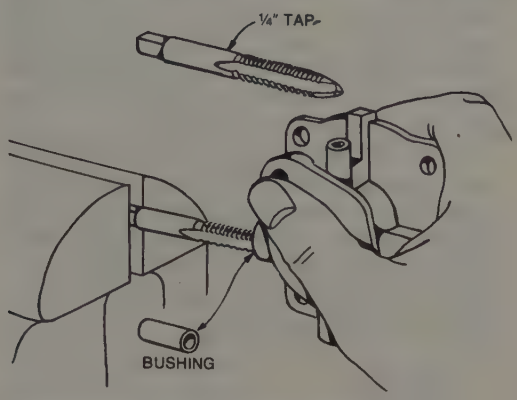
Cutaway view of a two piece Flo-Jet carburetor

Checking the Throttle Shaft and Bushings

Wear between the throttle shaft and bushings should not exceed 0.010 in. Check the wear by placing a short iron bar on the upper carburetor body so that it just fits under the throttle shaft. Measure the distance with a feeler gauge while holding the shaft down and then holding it up. If the difference is over 0.010 in., either the upper body should be rebushed, the throttle shaft replaced, or both. Wear on the throttle shaft can be checked by comparing the worn and unworn portions of the shaft. To replace the bushings, remove the throttle shaft using a thin punch to drive out the pin which holds the throttle stop to the shaft; remove the throttle valve, then pull out the shaft. Place a ¼ in. x 20 tap or an E-Z Out® in a vise. Turn the carburetor body so as to thread the tap or E-Z Out® into the bushings enough to pull the bushings out of the body. Press the new bushings into the carburetor body with a vise. Insert the throttle shaft to be sure it is free in the bushings. If not, run a size 7/32 in. drill through both bushings to act as a line reamer. Install the throttle shaft, valve, and stop.



Checking throttle shaft wear with a feeler gauge



Removing the throttle shaft bushing

Disassembly of the Carburetor

1. Remove the idle valve.
2. Loosen the needle valve packing nut.
3. Remove the packing nut and needle valve together. To remove the nozzle, use a narrow, blunt screwdriver so as not to damage the threads in the lower carburetor body. The nozzle projects diagonally into a recess in the upper body and must be removed before the upper body is separated from the lower body, or it may be damaged.
4. Remove the screws which hold the upper and lower bodies together. A pin holds the float in place.
5. Remove the pin to take out the float valve needle. Check the float for leakage. If it contains gasoline or is crushed, it must be replaced. Use a wide, proper fitting screwdriver to remove the float inlet seat.
6. Lift the venturi out of the lower body. Some carburetors have a welch plug. This should be removed only if necessary to remove the choke plate. Some carburetors have nylon choke shaft.

Repair

Use new parts where necessary. Always use new gaskets. Carburetor repair kits are available. Tighten the inlet seat with the gasket securely in place, if used. Some float valves have

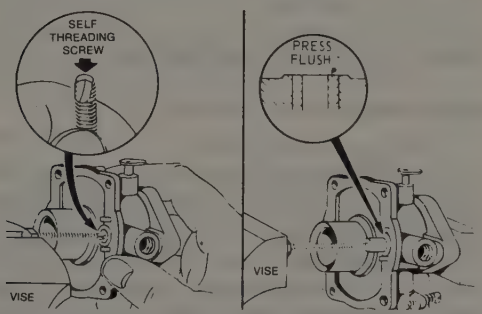
a spring clip to connect the float valve to the float tang. Others are nylon with a stirrup which fits over the float tang. Older float valves and engines with fuel pumps have neither a spring nor a stirrup.

A viton tip float valve is used in later models of the large, two-piece Flo-Jet carburetor. The seat is pressed into the upper body and does not need replacement unless it is damaged.

Replacing the Pressed-In Float Valve Seat

Clamp the head of a #93029 self threading screw in a vise. Turn the carburetor body to thread the screw into the seat. Continue turning the carburetor body, drawing out the seat. Leave the seat fastened to the screw. Insert the new seat #230996 into the carburetor body. The seat has a starting lead.

NOTE: *If the engine is equipped with a fuel pump, install a #231019 seat. Press the new seat flush with the body using the screw and old seat as a driver. Make sure that the seat is not pressed below the body surface or improper float-to-float valve contact will occur. Install the float valve.*



Replacing the float valve seat

Checking the Float Level

With the body gasket in place on the upper body and the float valve and float installed, the float should be parallel to the body mounting surface. If not, bend the tang on the float until they are parallel. Do not press on the flat to adjust it.

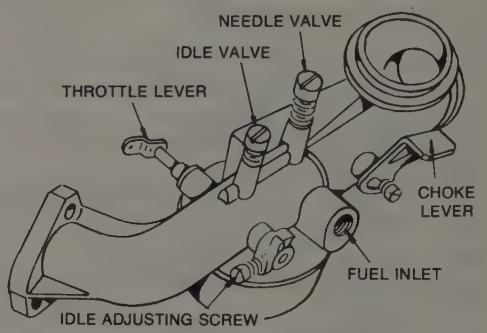
Assembly of the Carburetor

Assemble the venturi and the venturi gasket to the lower body. Be sure that the holes in the venturi and the venturi gasket are aligned. Some models do not have a removable venturi. Install the choke parts and welch plug if previously removed. Use a sealer around the welch plug to prevent entry of dirt.

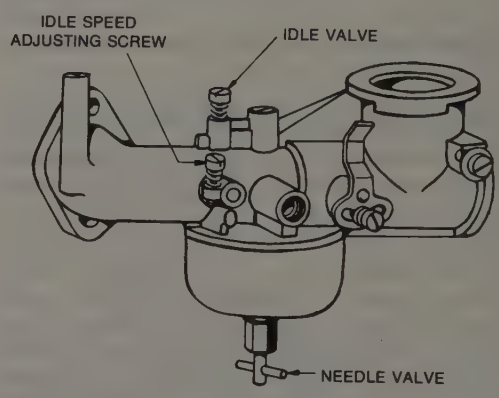
Fasten the upper and lower bodies together with the mounting screws. Screw in the nozzle with a narrow, blunt screwdriver, making sure that the nozzle tip enters the recess in the upper body. Tighten the nozzle securely. Screw in the needle valve and idle valve until they just seat. Back off the needle valve 1½ turns. Do not tighten the packing nut. Back off the idle valve ¾ of a turn. These settings are about correct. Final adjustment will be made when the engine is running. See the Tune-Up section for mixture and choke adjustments.

ONE-PIECE FLO-JET CARBURETOR

The large, one-piece Flo-Jet carburetor has its high speed needle valve below the float bowl. All other repair procedures are similar to the small, one-piece Flo-Jet carburetor.



Small one piece Flo-Jet carburetor



Large one piece Flo-Jet carburetor

Disassembly

1. Remove the idle and needle valves.
2. Remove the carburetor bowl screw. A pin holds the float in place.
3. Remove the pin to take off the float and float valve needle. Check the float for leakage. If it contains gasoline or is crushed, it must be replaced. Use a screwdriver to remove the carburetor nozzle. Use a wide, heavy screwdriver to remove the float valve seat, if used.

If it is necessary to remove the choke valve, venturi throttle shaft, or shaft bushings, proceed as follows.

1. Pry out the welch plug.

2. Remove the choke valve, then the shaft. The venturi will then be free to fall out after the choke valve and shaft have been removed.

3. Check the shaft for wear. (Refer to the "Two-Piece Flo-Jet Carburetor" section for checking wear and replacing bushings.)

Repair of the Carburetor

Use new parts where necessary. Always use new gaskets. Carburetor repair kits are available. If the venturi has been removed, install the venturi first, then the carburetor nozzle jets. The nozzle jet holds the venturi in place. Replace the choke shaft and valve. Install a new welch plug in the carburetor body. Use a sealer to prevent dirt from entering.

A viton tip float valve is used in the large, one-piece Flo-Jet carburetor. The seat is pressed in the upper carburetor body and does not need replacement unless it is damaged. Replace the seat in the same manner as for the two-piece Flo-Jet carburetor.

Checking the Float Level

With the body gasket in place on the upper body and float valve and the float installed, the float should be parallel to the body mounting surface. If not, bend the tang on the float until they are parallel. Do not press on the float.

Install the float bowl, idle valve, and needle valve. Turn in the needle valve and the idle valve until they just seat. Open the needle valve 2½ turns and the idle valve 1½ turns. On the large carburetors with the needle valve below the float bowl, open the needle valve and the idle valve 1⅛ turns.

These settings will allow the engine to start. Final adjustment should be made when the engine is running and has warmed up to operating temperature. See the "Two-Piece Flo-Jet Carburetor" adjustment procedure.

Float Level Chart

Carburetor Number	Float Setting (In.)
2712-S	19/64
2713-S	19/64
2714-S	1/4
*2398-S	1/4
2336-S	1/4
2336-SA	1/4
2337-S	1/4
2337-SA	1/4
2230-S	17/64
2217-S	11/64

*When resilient seat is used, set float level at 9/32 ± 1/64.

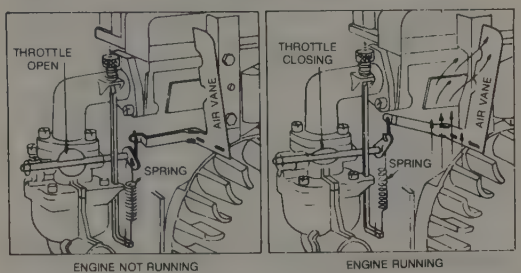
Governors

The purpose of a governor is to maintain, within certain limits, a desired engine speed even though the load may vary.

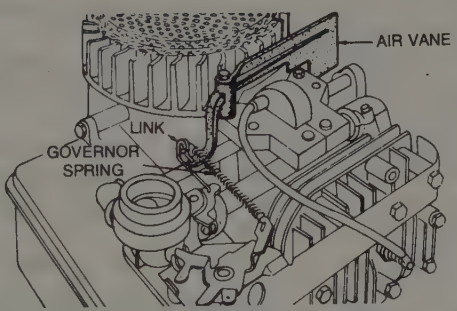
AIR VANE GOVERNORS

The governor spring tends to open the throttle. Air pressure against the air vane tends to close the throttle. The engine speed at which these two forces balance is called the governed speed. The governed speed can be varied by changing the governor spring tension.

Worn linkage or damaged governor springs should be replaced to insure proper governor operation. No adjustment is necessary.



Air vane governor installed on horizontal crankshaft engine



Air vane governor installed on vertical crankshaft engine

MECHANICAL GOVERNORS

The governor spring tends to pull the throttle open. The force of the counterweights, which are operated by centrifugal force, tends to close the throttle. The engine speed at which these two forces balance is called the governed speed. The governed speed can be varied by changing the governor spring tension.

GOVERNOR REPAIR

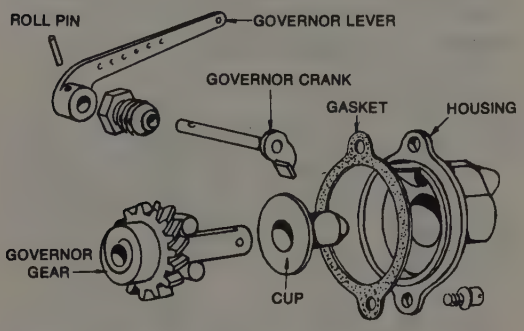
The procedures below describe disassembly and assembly of the various kinds of mechani-

cal governors. Look for gears with worn or broken teeth, worn thrust washers, weight pins, cups, followers, etc. Replace parts that are worn and reassemble.

Models N, 6, 8

DISASSEMBLY

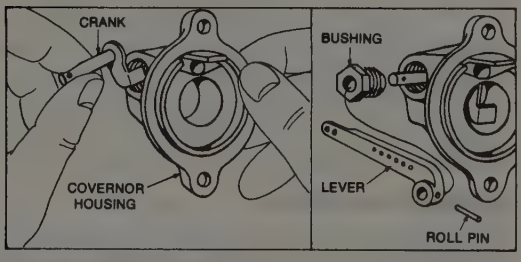
1. Remove the two governor housing mounting screws, and remove the housing.
2. Pull the cup off the governor gear, and then slide the gear off the shaft.
3. Disassemble the governor crank by driving the roll pin out of the end of the governor lever and then remove the crank bushing. Pull the governor crank out of the housing.



Governor housing and gear assembly

ASSEMBLY

1. Push the governor crank, lever end first, into the housing.
2. Slip the bushing onto the shaft, and then thread it into the housing and tighten securely.
3. Position the lever on the shaft with the lever and shaft pin holes lined up and the lever pointing away from the housing mounting flange. Push in the pin.
4. Push the governor gear onto the shaft in the engine block.
5. Position the gasket on the governor housing, put the housing into position on the block, and install the two housing mounting screws. Connect linkage.

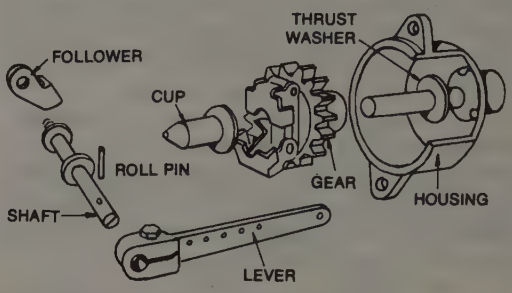


Installing crank and lever

Models 6B, 8B, 60000, 80000

DISASSEMBLY

1. Loosen the governor lever mounting screw, and pull the lever off the shaft.
2. Remove the two housing mounting screws. Carefully pull the housing off the block, being careful to catch the governor gear, which will slip off the shaft. Pull the steel thrust washer off the shaft.
3. Remove the governor lever roll pin and washer. Unscrew the governor lever shaft by turning it clockwise and remove it.



Mechanical governor exploded view

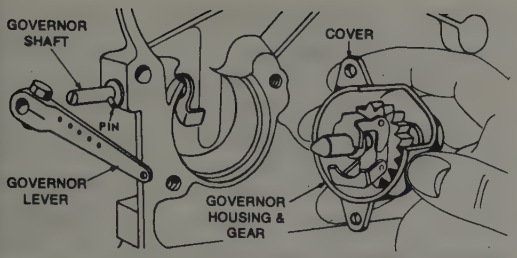
ASSEMBLY

1. Push the governor lever shaft into the crankcase cover, threaded end first. Assemble the small washer onto the inner end of the shaft, and then screw the shaft into the governor crank follower by turning it counter clockwise. Tighten it securely.
2. Turn the shaft until the follower points down slightly, in a position where it would press against the cup when the housing is installed.
3. Place the washer on the outside end of the shaft. Install the rollpin, so the leading end just reaches the outside diameter of the shaft and the back end protrudes.
4. Install the thrust washer and the governor gear on the shaft in the housing (in that order).
5. Hold the crankcase cover in a vertical (the normal) position and install the housing with the gear in position so the point of the steel cup on the gear contacts the follower. Install and tighten the housing mounting screws.
6. Install the lever on the shaft pointing downward at an angle of about 30 degrees. Adjust as described in the Tune-Up section.

Cast Iron Models

DISASSEMBLY

1. Remove the cotter key and washer from the outer end of the governor shaft. Remove the governor crank from inside the crankcase.
2. Slide the governor gear off the shaft.



Assembling the mechanical governor

ASSEMBLY

1. Install the governor gear onto the shaft inside the crankcase. Then, insert the governor shaft assembly through the bushing from inside the crankcase.

2. Install the governor lever to the shaft loosely, and then adjust it as described in the Tune-Up section.

Aluminum Models

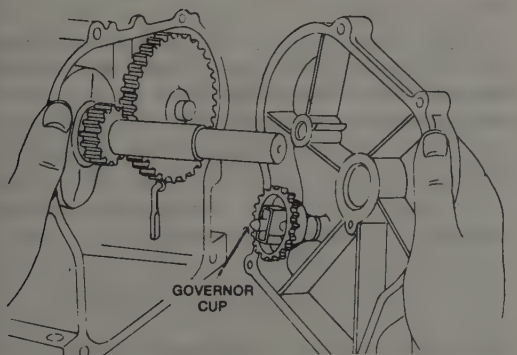
DISASSEMBLY

On horizontal shaft models: Remove the governor assembly as a unit from the crankcase cover.

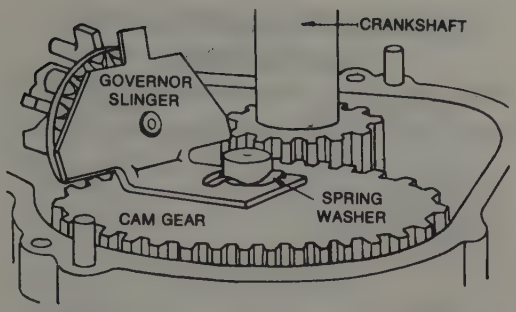
On vertical shaft models: Remove the entire assembly as part of the oil slinger (see the Overhaul Section).

ASSEMBLY

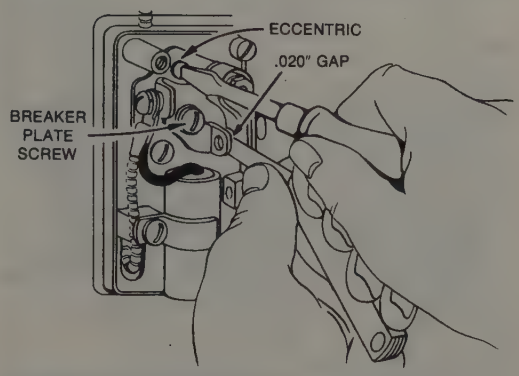
1. Assemble governors on horizontal crankshaft models with crankshaft in a horizontal position. The governor rides on a short stationary shaft which is integral with the crankcase cover. The governor shaft keeps the governor from sliding off the shaft after the cover is installed. The governor shaft *must* hang straight down, or it may jam the governor assembly when the crankcase cover is installed, breaking it when the engine is started. The governor shaft adjustment should be made (see the Tune-Up section) as soon as the crankcase cover is in place so that the governor lever will be clamped in the proper position.



Assembling cover with governor and governor shaft in proper position (horizontal shaft engines)



Installing spring on camshaft (Models 100900 and 130900)



Adjusting the breaker point gap

2. On both horizontal and vertical crankshaft models, the governor is held together through normal operating forces. For this reason, the governor link and all other external linkages must be in place and properly adjusted whenever the engine is operated.

3. On vertical shaft models 100900 and 130900, be sure the spring washer is in place on the camshaft after the governor is in position.

ENGINE OVERHAUL

Cylinder Head

REMOVAL AND INSTALLATION

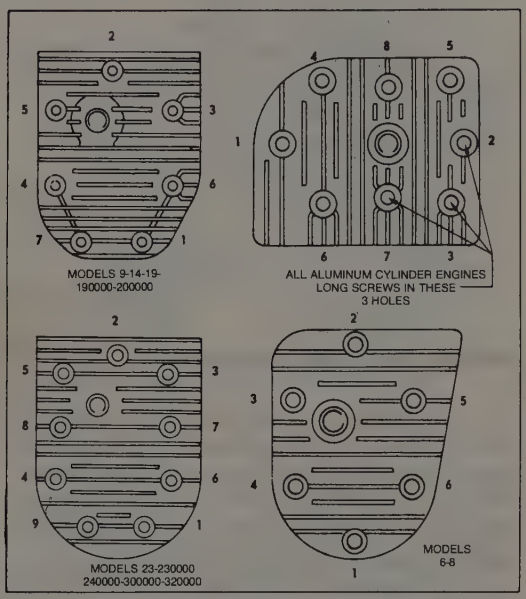
Always note the position of the different cylinder head screws so that they can be properly reinstalled. If a screw is used in the wrong position, it may be too short and not engage enough threads. If it is too long, it may bottom on a fin, either breaking the fin, or leaving the cylinder head loose.

Remove the cylinder screws and then the cylinder head. Be sure to remove the gasket and all remaining gasket material from the cylinder head and the block.

Assemble the cylinder head with a new gas-

Cylinder Head Bolt Torque Specifications

Basic Model Series	In. lbs. Torque
Aluminum Cylinder	
6B, 60000, 8B, 80000 82000, 92000, 110000, 100000, 130000	140
Cast Iron Cylinder	
5, 6, N, 8, 9	140
14	165


MODELS 9-14-19-190000-200000
ALL ALUMINUM CYLINDER ENGINES LONG SCREWS IN THESE 3 HOLES
MODELS 23-230000 240000-300000-320000
MODELS 6-8

Cylinder head bolt tightening sequences

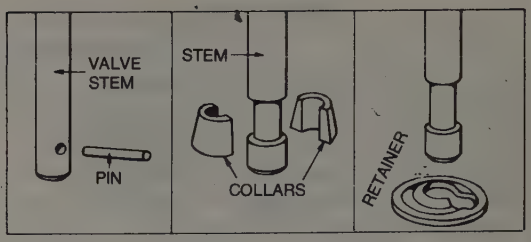
ket, cylinder head shield, screws, and washers in their proper places. Graphite grease should be used on aluminum cylinder head screws.

Do not use a sealer of any kind on the head gasket. Tighten the screws down evenly by hand. Use a torque wrench and tighten the head bolts in the correct sequence.

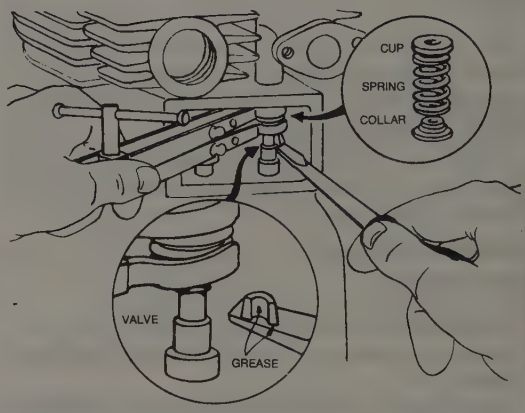
Valves

REMOVAL AND INSTALLATION

Using a valve spring compressor, adjust the jaws so they touch the top and bottom of the valve chamber, and then place one of the jaws over the valve spring and the other underneath, between the spring and the valve chamber. This positioning of the valve spring compressor is for valves that have either pin or collar type retainers. Tighten the jaws to



The three types of valve spring retainers



Removing the valve springs with the help of a valve spring compressor

compress the spring. Remove the collars or pin and lift out the valve. Pull out the compressor and the spring.

To remove valves with ring type retainers, position the compressor with the upper jaw over the top of the valve chamber and the lower jaw between the spring and the retainer. Compress the spring, remove the retainer, and pull out the valve. Remove the compressor and spring.

Before installing the valves, check the thickness of the valve springs. Some engines use the same spring for the intake and exhaust side, while others use a heavier spring on the exhaust side. Compare the springs before installing them.

If the retainers are held by a pin or collars, place the valve spring and retainer and cup (Models 9-14-19-20-23-24-32) into the valve spring compressor. Compress the spring until it is solid. Insert the compressed spring and retainer into the valve chamber. Then drop the valve into place, pushing the stem through the retainer. Hold the spring up in the chamber, hold the valve down, and insert the retainer pin with needle nose pliers or place the collars in the groove in the valve stem. Loosen the spring until the retainer fits around the pin or collars, then pull out the spring compressor. Be sure the pin or collars are in place.

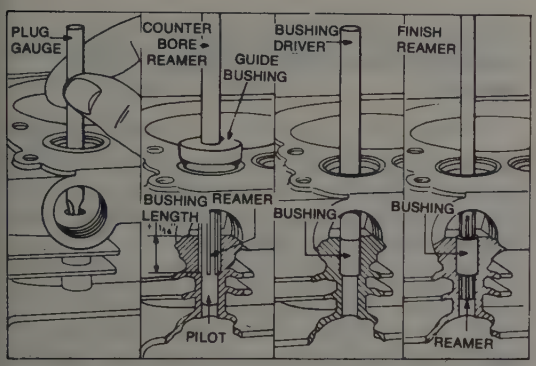
To install valves with ring type retainers, compress the retainer and spring with the compressor. The large diameter of the retainer should be toward the front of the valve chamber. Insert the compressed spring and retainer into the valve chamber. Drop the valve stem through the larger area of the retainer slot and move the compressor so as to center the small area of the valve retainer slot onto the valve stem shoulder. Release the spring tension and remove the compressor.

Valve Guides

REMOVAL AND INSTALLATION

Aluminum Models

First check valve guide for wear with a plug gauge, Briggs & Stratton, Part #19122 or equivalent. If the flat end of valve guide plug gauge can be inserted into the valve guide for a distance of $^5/_{16}$", the valve guide is worn and should be rebushed in the following manner. See the illustration.



Bushing the valve guide

Procure a reamer (part #19064) and a reamer guide bushing (part #19191). Equivalent tools available from other sources may be used. Lubricate the reamer with kerosene. Use reamer and reamer guide bushing to ream out the worn guide. Ream to only $^1/_{16}$" deeper than valve guide bushing #63709. BE CAREFUL NOT TO REAM THROUGH THE GUIDE.

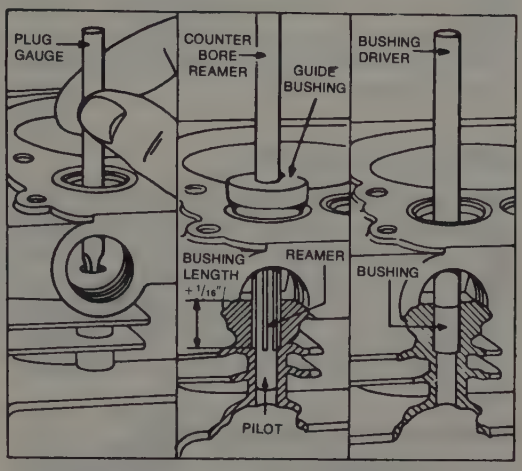
Press in valve guide bushing #63709 until top end of bushing is flush with top end of valve guide. Use a soft metal driver (brass, copper, etc.) or driver #19065 so top end of bushing is not peened over.

Procure a reamer #19066 (or equivalent), lubricate it with kerosene, and finish reaming the bushing. A standard valve can now be used.

NOTE: *It is usually not necessary to bush factory installed brass valve guides. However, if bushing is required, DO NOT REMOVE ORIGINAL BUSHING, but follow standard procedure outlined.*

Cast Iron Models

First check valve guide for wear with a plug gauge, Briggs & Stratton part #19151 or equivalent. If the flat end of the valve guide plug gauge can be inserted into the valve guide for a distance of $^5/_{16}$", the guide is worn and should be rebushed in the following manner. See the illustration.



Bushing the valve guide

Procure a reamer #19183 and reamer guide bushing #19192, and lubricate the reamer with kerosene. Then, use reamer and reamer guide bushing to ream out the worn guide. Ream to only $^1/_{16}$" deeper than valve guide bushing #230655. BE CAREFUL NOT TO REAM THROUGH THE GUIDE.

Press in valve guide bushing #230655 until top end of bushing is flush with top end of valve guide. Use a soft metal driver (brass, copper, etc.) so top end of bushing is not peened over.

The bushing #230655 is finish reamed to size at the factory, so no further reaming is necessary, and a standard valve can be used.

CAUTION: *Valve seating should be checked after bushing the guide, and corrected if necessary by refacing the seat.*

REFACING VALVES AND SEATS

Faces on valves and valve seats should be resurfaced with a valve grinder or cutter to an angle of 45°.

NOTE: *Some engines have a 30° intake valve and seat.*

The valve and seat should then be lapped with a fine lapping compound to remove the grinding marks and ensure a good seat. The valve seat width should be $^3/_{64}$–$^1/_{16}$ in. If the seat is wider, a narrowing stone or cutter should be used. If either the seat or valve is

badly burned, it should be replaced. Replace the valve if the edge thickness (margin) is less than 1/64 in. after it has been resurfaced.

CHECK AND ADJUST TAPPET CLEARANCE

Insert the valves in their respective positions in the cylinder. Turn the crankshaft until one of the valves is at its highest position. Turn the crankshaft one revolution. Check the clearance with a feeler gauge. Repeat for the other valve. Grind off the end of the valve stem if necessary to obtain proper clearance.

NOTE: *Check the valve tappet clearance with the engine cold.*

Valve Seat Inserts

Cast iron cylinder engines are equipped with an exhaust valve insert which can be removed and replaced with a new insert. The intake side must be counterbored to allow the installation of an intake valve seat insert (see below). Aluminum alloy cylinder models are equipped with inserts on both the exhaust and intake valves.

REMOVAL AND INSTALLATION

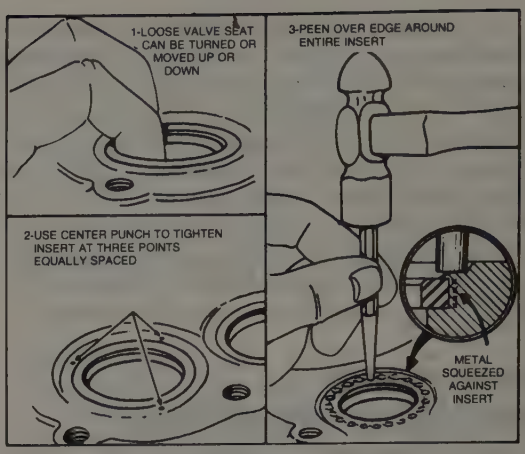
Valve seat inserts are removed with a special puller.

NOTE: *On aluminum alloy cylinder models, it may be necessary to grind the puller nut until the edge is 1/32 in. thick in order to get the puller nut under the valve insert.*

When installing the valve seat insert, make sure that the side with the chamfered outer edge goes down into the cylinder. Install the seat insert and drive it into place with a driver. The seat should then be ground lightly and the valves and seats lapped lightly with grinding compound.

NOTE: *Aluminum alloy cylinder models use the old insert as a spacer between the driver and the new insert. Drive in the new insert until it bottoms. The top of the insert will be slightly below the cylinder head gasket surface. Peen around the insert using a punch and hammer.*

NOTE: *The intake valve seat on cast iron cylinder models has to be counterbored before installing the new valve seat insert.*


1-LOOSE VALVE SEAT CAN BE TURNED OR MOVED UP OR DOWN
2-USE CENTER PUNCH TO TIGHTEN INSERT AT THREE POINTS EQUALLY SPACED
3-PEEN OVER EDGE AROUND ENTIRE INSERT
METAL SQUEEZED AGAINST INSERT

Installing valve seat inserts

COUNTERBORING CYLINDER FOR INTAKE VALVE SEAT ON CAST IRON MODELS

1. Select the proper seat insert, cutter shank, counter bore cutter, pilot and driver from the table. These numbers refer to Briggs & Stratton parts—you may get equivalent parts from other sources if available.
2. With cylinder head resting on a flat surface, valve seats up, slide the pilot into the intake valve guide. Then, assemble the correct counterbore cutter to the shank with the cutting blades of the cutter downward.
3. Insert the cutter straight into the valve seat, over the pilot. Cut so as to avoid forcing the cutter to one side, and be sure to stop as soon as the stop on the cutter touches the cylinder head.
4. Blow out all cutting chips thoroughly.

Valve Tappet Clearance Chart

Model Series	Intake		Exhaust	
	Max	Min	Max	Min
Aluminum Cylinder				
6B, 60000, 8B, 80000	.007	.005	.011	.009
82000, 92000, 100000, 110900	.007	.005	.011	.009
130000	.007	.005	.011	.009
Cast Iron Cylinder				
5, 6, 8, N, 9, 14	.009	.007	.016	.014

Valve Seat Inserts Chart

Basic Model Series	Intake Standard	Exhaust Standard	Exhaust Stellite	Insert # Puller Assembly	Puller Nut
Aluminum Cylinder					
6B, 8B	211291	211291	210452	19138	19140 Ex. 19182 In.
60000, 80000	210879*	211291	210452	19138	19140 Ex. 19182 In.
82000, 92000, 110000	210879	211291	210452	19138	19140 Ex. 19182 In.
100000, 130000	211158	211172	211436	19138	19182 Ex. 19139 In.
Cast Iron Cylinder					
5, 6, N	63838	21865		19138	19140
8	210135	21865		19138	19140
9	63007	63007		19138	19139
14	21880	21880	21612	19138	19141

*21191 used before serial #5810060—210808 used from serial #5810060—6012010
Includes puller and #19182, 19141, 19140 and 19139 nuts

Pistons, Piston Rings, and Connecting Rods

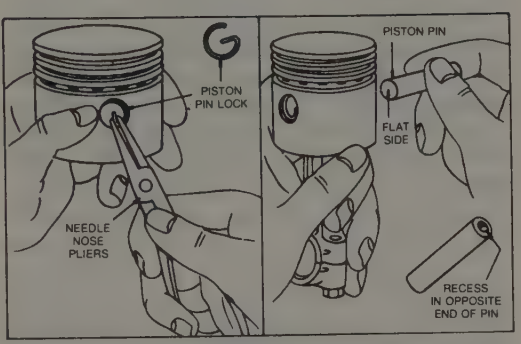
REMOVAL

To remove the piston and connecting rod from the engine, bend down the connecting rod lock. Remove the connecting rod cap. Remove any carbon or ridge at the top of the cylinder bore. This will prevent breaking the rings. Push the piston and rod out of the top of the cylinder.

Pistons used in sleeve bore, aluminum alloy engines are marked with an "L" on top of the piston. These pistons are tin plated and use an expander with the oil ring. This piston assembly is not interchangeable with the piston used in the aluminum bore engines (Kool bore).

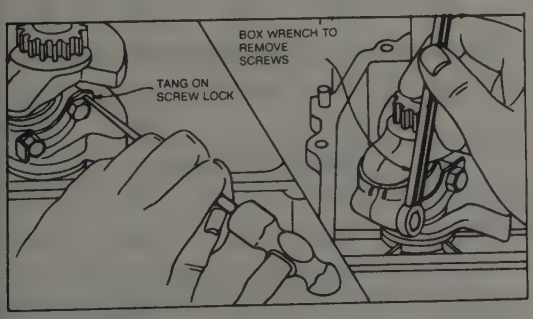
Pistons used in aluminum bore (Kool bore) engines are not marked on the top.

To remove the connecting rod from the piston, remove the piston pin lock with thin nose pliers. One end of the pin is drilled to facilitate removal of the lock.

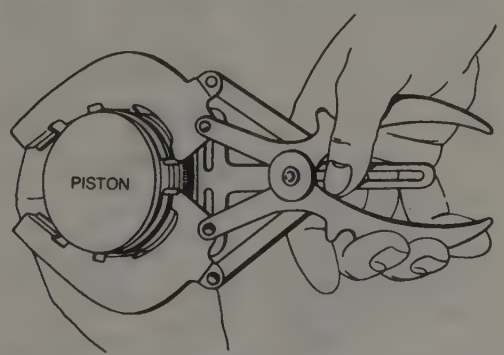


Removing the wrist pin and connecting rod from the piston

Remove the rings one at a time, slipping them over the ring lands. Use a ring expander to remove the rings.



Removing the connecting rod cap



Replacing the piston rings

INSPECTION

Check the piston ring fit. Use a feeler gauge to check the side clearance of the top ring. Make sure that you remove all carbon from the top ring groove. Use a new piston ring to check the side clearance. If the cylinder is to be resized, there is no reason to check the piston, since a new oversized piston assembly will be installed. If the side clearance is more than 0.007 in., the piston is excessively worn and should be replaced.

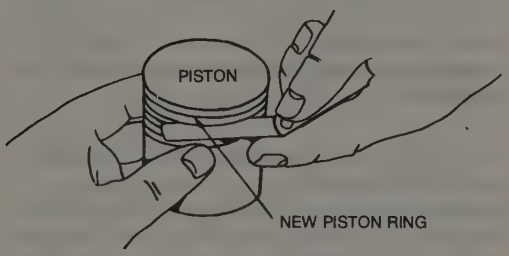
Check the piston ring end gap by cleaning all carbon from the ends of the rings and inserting them one at a time 1 in. down into the cylinder. Check the end gap with a feeler gauge. If the gap is larger than recommended, the ring should be replaced.

NOTE: *When checking the ring gap, do not deglaze the cylinder walls by installing piston rings in aluminum cylinder engines.*

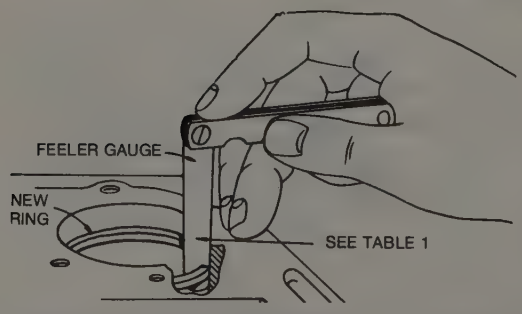
Chrome ring sets are available for all current aluminum and cast iron cylinder models. No honing or deglazing is required. The cylinder bore can be a maximum of 0.005 in. oversize when using chrome rings.

If the crankpin bearing in the rod is scored, the rod must be replaced. 0.005 in. oversize piston pins are available in case the connecting rod and piston are worn at the piston pin bearing. If, however, the crankpin bearing in the connecting rod is worn, the rod should be replaced. Do not attempt to file or fit the rod.

If the piston pin is worn 0.0005 in. out of round or below the rejection sizes, it should be replaced.



Measuring piston ring side gap



Measuring the piston ring gap

INSTALLATION

The piston pin is a push fit into both the piston and the connecting rod. On models using a solid piston pin, one end is flat and the other end is recessed. Other models use a hollow piston pin. Place a pin lock in the groove at one side of the piston. From the opposite side of the piston, insert the piston pin, flat end first for solid pins; with hollow pins, insert either end first until it stops against the pin lock. Use thin nose pliers to assemble the pin lock in the recessed end of the piston. Be sure the locks are firmly set in the groove.

Install the rings on the pistons, using a piston ring expander. Make sure that they are installed in the proper position. The scraper groove on the center compression ring should always be down toward the piston skirt. Be sure the oil return holes are clean and all carbon is removed from the grooves.

NOTE: *Install the expander under the oil ring in sleeve bore aluminum alloy engines.*

Connecting Rod Bearing Specifications

Basic Model Series	Crank Pin Bearing	Piston Pin Bearing
Aluminum Cylinder		
6B, 60000	.876	.492
8B, 80000	1.001	.492
82000, 92000, 110000	1.001	.492
100000	1.001	.555
130000	1.001	.492
Cast Iron Cylinder		
5	.752	.492
6, 8, N	.751	.492
9	.876	.563
14	1.001	.674

Piston Ring Gap Specifications

Basic Model Series	Comp. Ring	Oil Ring
Aluminum Cylinder		
6B, 60000, 8B, 80000		
82000, 92000, 110000, 111000	.035	.045
Cast Iron Cylinder		
5, 6, 8, N, 9	.035	.035

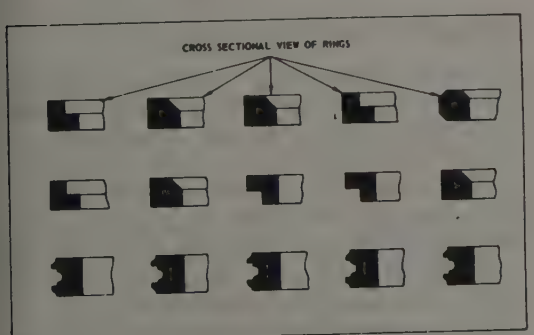
Wrist Pin Specifications

Basic Model Series	Piston Pin	Pin Bore
Aluminum Cylinder		
6B, 60000	.489	.491
8B, 80000	.489	.491
82000, 92000, 110000, 111000	.489	.491
100000	.552	.554
130000	.489	.491
Cast Iron Cylinder		
5, 6, 8, N	.489	.491
9	.561	.563
14	.671	.673

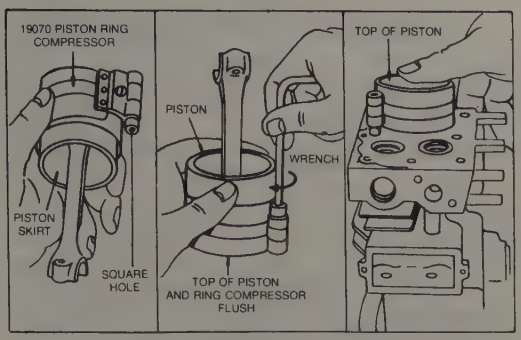
Oil the rings and the piston skirt, then compress the rings with a ring compressor. On cast iron engines, install the compressor with the two projections downward; on aluminum engines, install the compressor with the two projections upward. These instructions refer to the piston in normal position—with skirt downward. Turn the piston and compressor upside down on the bench and push downward so the piston head and the edge of the compressor band are even, all the while tightening the compressor. Draw the compressor up tight to fully compress the rings, then loosen the compressor very slightly.

CAUTION: *Do not attempt to install the piston and ring assembly without using a ring compressor.*

Place the connecting rod and piston assembly, with the rings compressed, into the cylinder bore. Push the piston and rod down into the cylinder. Oil the crankpin of the crankshaft. Pull the connecting rod against the crankpin and assemble the rod cap so the assembly marks align.



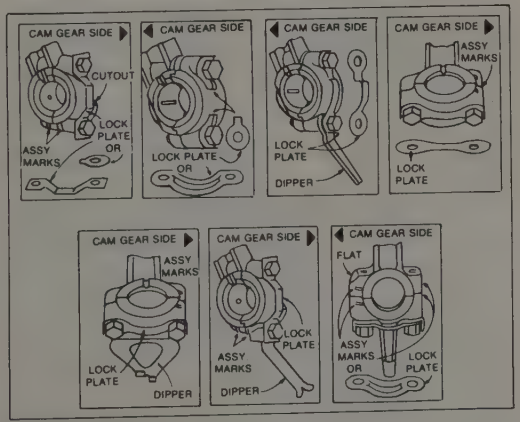
Cross-sectional views and positioning of the various types of piston rings used in Briggs and Stratton engines



Installing the piston and connecting rod assembly into the cylinder block

NOTE: *Some rods do not have assembly marks, as the rod and cap will fit together only in one position. Use care to ensure proper installation. On the 251000 engine, the piston has a notch on the top surface. The notch must face the flywheel side of the block when installed. On models 300000 and 320000, the piston has an identification mark "F" located next to the piston pin bore. The mark must appear on the same side as the assembly mark on the rod. The assembly mark on the rod is also used to identify rod and cap alignment. Note, on these pistons, that the top ring has a beveled upper surface on the outside, while the center ring has a flat outer surface. The "F" mark or notch must face the flywheel when the piston is installed.*

Where there are flat washers under the cap screws, remove and discard them prior to installing the rod. Assemble the cap screws and screw locks with the oil dippers (if used), and torque to the figure shown in the chart to avoid breakage or rod scoring later. Turn the crankshaft two revolutions to be sure the rod is correctly installed. If the rod strikes the camshaft, the connecting rod has been installed wrong



Connecting rod installation

Connecting Rod Capscrew Torque

Basic Model Series	Inch lbs Avg. Torque
Aluminum Cylinder	
6B, 60000	100
8B, 80000	100
82000, 92000, 110000, 111000	100
100000, 130000	100
Cast Iron Cylinder	
5, 6, N, 8	100
9	140
14	190

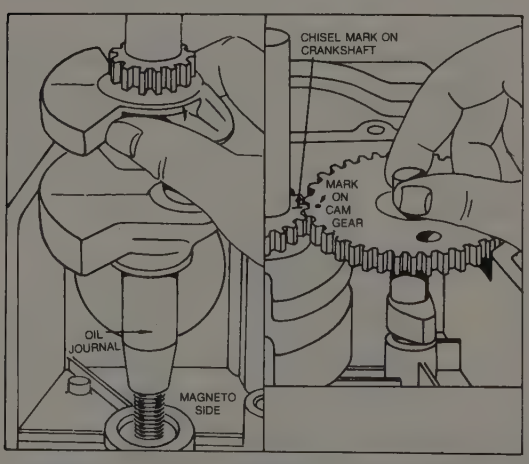
or the cam gear is out of time. If the crankshaft operates freely, bend the cap screw locks against the screw heads. After tightening the rod screws, the rod should be able to move sideways on the crankpin of the shaft.

Crankshaft and Camshaft Gear

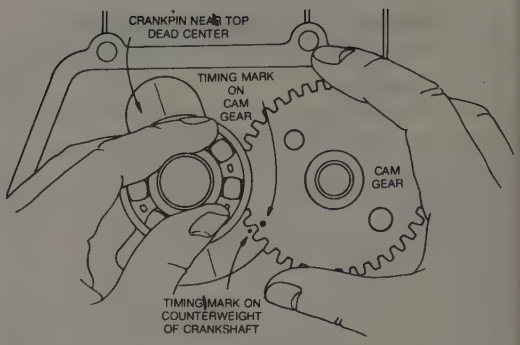
REMOVAL

Aluminum Cylinder Engines

To remove the crankshaft from aluminum alloy engines, remove any rust or burrs from the power take-off end of the crankshaft. Remove the crankcase cover or sump. If the sump or cover sticks, tap it lightly with a soft hammer on alternate sides near the dowel. Turn the crankshaft to align the crankshaft and camshaft timing marks, lift out the cam gear, then remove the crankshaft. On models that have ball bearings on the crankshaft, the crankshaft and the camshaft must be removed together with the timing marks properly aligned—see illustration.



Alignment of the camshaft and crankshaft timing marks



Alignment of the camshaft and crankshaft timing marks on engines equipped with ball bearings

Cast Iron Cylinder Models

To remove the crankshaft from cast iron models, remove the crankcase cover. Revolve the crankshaft until the crankpin is pointing upward toward the breather at the rear of the engine (approximately a 45° angle). Pull the crankshaft out from the drive side, twisting it slightly if necessary. On models with ball bearings on the crankshaft, both the crankcase cover and bearing support should be removed.

On cast iron models with ball bearings on the drive side, first remove the magneto. Drive out the camshaft. Push the camshaft forward into the recess at the front of the engine. Then draw the crankshaft from the magneto side of the engine. Double thrust engines have cap screws inside the crankcase which hold the bearing in place. These must be removed before the crankshaft can be removed.

To remove the camshaft from all cast iron models, except the 300400 and 320400, use a long punch to drive the camshaft out toward the magneto side. Save the plug. Do not burr or peen the end of the shaft while driving it out. Hold the camshaft while driving it out. Hold the camshaft while removing the punch, so it will not drop and become damaged.

CHECKING THE CRANKSHAFT

Discard the crankshaft if it is worn beyond the allowable limit. Check the keyways for wear and make sure they are not spread. Remove all burrs from the keyway to prevent scratching the bearing. Check the three bearing journals, drive end, crankpin, and magneto end, for size and any wear or damage. Check the cam gear teeth for wear. They should not be worn at all. Check the threads at the magneto end for damage. Make sure that the crankshaft is straight.

NOTE: *There are 0.020 in. undersize connecting rods available for use on reground crankpin bearings.*

Crankshaft Specifications

Basic Model Series	PTO Journal	Mag. Journal	C Crankpin
Aluminum Cylinder			
6B, 60000	.873	.873	.870
8B, 80000*	.873	.873	.996
82000, 92000*, 110900*	.873	.873	.996
100000, 130000	.998	.873	.996
Cast Iron Cylinder			
5, 6, 8, N	.873	.873	.743
9	.983	.983	.873
14	1.179	1.179	.996

*Auxiliary drive models P.T.O. bearing reject size—1.003

Camshaft Specifications

Basic Model Series	Cam Gear or Shaft Journals	Cam Lobe
Aluminum Cylinder		
6B, 60000	.498	.883
8B, 80000*	.498	.883
82000, 92000	.498	.883
110900	.436 MAG. .498 PTO.	.870
100000, 130000	.498	.950
Cast Iron Cylinder		
5, 6, 8, N	.372	.875
9	.372	1.124
14	.497	1.115

*Auxiliary drive models P.T.O. .751

Removal and Installation of the Ball Bearings

The ball bearings are pressed onto the crankshaft. If either the bearing or the crankshaft is to be removed, use an arbor press to remove them.

To install, heat the bearing in hot oil (325° F maximum). Don't let the bearing rest on the bottom of the pan in which it is heated. Place the crankshaft in a vise with the bearing side up. When the bearing is quite hot, it will slip fit onto the bearing journal. Grasp the bearing, with the shield down, and thrust it down onto the crankshaft. The bearing will tighten on the shaft while cooling. Do not quench the bearing (throw water on it to cool it).

CHECKING THE CAMSHAFT GEAR

Inspect the teeth for wear and nicks. Check the size of the camshaft and camshaft gear bearing journals. Check the size of the cam lobes. If the cam is worn beyond tolerance, discard it.

Check the automatic spark advance on models equipped with the Magna-Matic ignition system. Place the cam gear in the normal operating position with the movable weight down. Press the weight down and release it. The spring should lift the weight. If not, the spring is stretched or the weight is binding.

INSTALLATION

Aluminum Alloy Engines—Plain Bearing

In aluminum alloy engines, the tappets are inserted first, the crankshaft next, and then the cam gear. When inserting the cam gear, turn the crankshaft and the cam gear so that the timing marks on the gears align.

Aluminum Alloy Engines—Ball Bearing

On crankshafts with ball bearings, the gear teeth are not visible for alignment of the timing marks; therefore, the timing mark is on the counterweight. On ball bearing equipped engines, the tappets are installed first. The crankshaft and the cam gear must be inserted together and their timing marks aligned.

Crankshaft Cover and Crankshaft

INSTALLATION

Models 100900 and 130900

On these models, install the governor slinger onto the cam gear with the spring washer.

To protect the oil seal while assembling the crankcase cover, put oil or grease on the sealing edge of the oil seal. Wrap a piece of thin cardboard around the crankshaft so the seal will slide easily over the shoulder of the crankshaft. If the sharp edge of the oil seal is cut or bent under, the seal may leak.

Cast Iron Engines—Plain Bearings

Assemble the tappets to the cylinder, then insert the cam gear. Push the camshaft into the camshaft hole in the cylinder from the flywheel side through the cam gear. With a blunt punch, press or hammer the camshaft until the end is flush with the outside of the cylinder on the power takeoff side. Place a small amount of sealer on the camshaft plug, then press or hammer it into the camshaft hole in the cylin-

der at the flywheel side. Install the crankshaft so the timing marks on the teeth and on the cam gear align.

Cast Iron—Ball Bearings

Assemble the tappets, then insert the cam gear into the cylinder, pushing the cam gear forward into the recess in front of the cylinder. Insert the crankshaft into the cylinder. Turn the camshaft and crankshaft until the timing marks align, then push the cam gear back until it engages the gear on the crankshaft with the timing marks together. Insert the camshaft. Place a small amount of sealer on the camshaft plug and press or hammer it into the camshaft hole in the cylinder at the flywheel side.

Crankshaft End-Play Adjustment

The crankshaft end-play on all models, plain and ball bearing, should be 0.002 in. to 0.008 in. The method of obtaining the correct end-play varies, however, between cast iron, aluminum, plain, and ball bearing models. New gasket sets include three crankcase cover or bearing support gaskets, 0.005 in., 0.009 in., and 0.015 in. thick.

The end-play of the crankshaft may be checked by assembling a dial indicator on the crankshaft with the pointer against the crankcase. Move the crankshaft in and out. The indicator will show the end-play. Another way to measure the end-play is to assemble a pulley to the crankshaft and measure the end-play with a feeler gauge. Place the feeler gauge between the crankshaft thrust face and the bearing support. The feeler gauge method of measuring crankshaft end-play can only be used on cast iron plain bearing engines with removable bases.

On cast iron engines, the end-play should be 0.002 in. to 0.008 in. with one 0.015 in. gasket in place. If the end-play is less than 0.002 in., which would be the case if a new crankcase or sump cover is used, additional gaskets of 0.005 in., 0.009 in., or 0.015 in. may be added in various combinations to obtain the proper end-play.

ALUMINUM ENGINES ONLY

If the end-play is more than 0.008 in. with one 0.015 in. gasket in place, a thrust washer is available to be placed on the crankshaft power take-off end, between the gear and crankcase cover or sump on plain bearing engines. On ball bearing equipped aluminum engines, the thrust washer is added to the magneto end of the crankshaft instead of the power take-off end.

NOTE: *Aluminum engines never use less than the 0.015 in. gasket.*

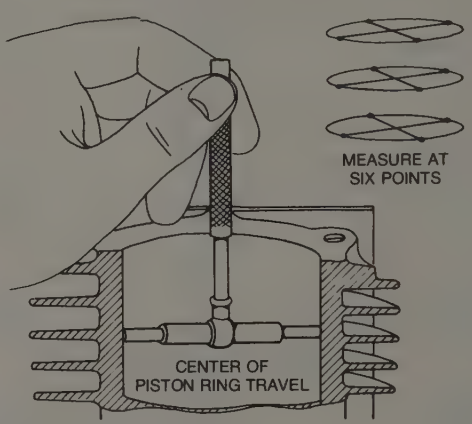
Cylinders

INSPECTION

Always inspect the cylinder after the engine has been disassembled. Visual inspection will show if there are any cracks, stripped bolt holes, broken fins, or if the cylinder wall is scored. Use an inside micrometer or telescoping gauge and micrometer to measure the size of the cylinder bore. Measure at right angles.

If the cylinder bore is more than 0.003 in. oversize, or 0.0015 in. out of round on lightweight (aluminum) cylinders, the cylinder must be resized (rebored).

NOTE: *Do not deglaze the cylinder walls when installing piston rings in aluminum cylinder engines. Also be aware that there are chrome ring sets available for most engines. These are used to control oil pumping in bores worn to 0.005 in. over standard and do not require honing or glaze breaking to seat.*



Checking the cylinder bore

RESIZING

Always resize to exactly 0.010 in., 0.020 in., or 0.030 in. over standard size. If this is done accurately, the stock oversize rings and pistons will fit perfectly and proper clearances will be maintained. Cylinders, either cast iron or lightweight, can be quickly resized with a good hone. Use the stones and lubrication recommended by the hone manufacturer to produce the correct cylinder wall finish for the various engine models.

If a boring bar is used, a hone must be used after the boring operation to produce the proper cylinder wall finish. Honing can be done with a portable electric drill, but it is easier to use a drill press.

1. Clean the cylinder at top and bottom to remove all burrs and pieces of base and head gaskets.

2. Fasten the cylinder to a heavy iron plate. Some cylinders require shims. Use a level to align the drill press spindle with the bore.

3. Oil the surface of the drill press table liberally. Set the iron plate and the cylinder on the drill press table. Do not anchor the cylinder to the drill press table. If you are using a portable drill, set the plate and the cylinder on the floor.

4. Place the hone driveshaft in the chuck of the drill.

5. Slip the hone into the cylinder. Connect the driveshaft to the hone and set the stop on the drill press so the hone can only extend ¾ in. to 1 in. from the top or bottom of the cylinder. If you are using a portable drill, cut a piece of wood to place in the cylinder as a stop for the hone.

6. Place the hone in the middle of the cylinder bore. Tighten the adjusting knob with your finger or a small screwdriver until the stones fit snugly against the cylinder wall. Do not force the stones against the cylinder wall. The hone should operate at a speed of 300–700 rpm. Lubricate the hone as recommended by the manufacturer.

NOTE: *Be sure that the cylinder and the hone are centered and aligned with the driveshaft and the drill spindle.*

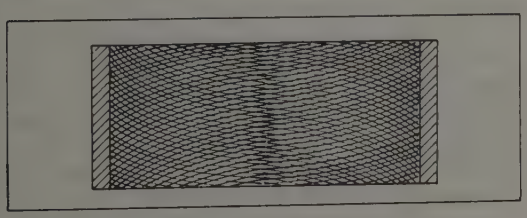
7. Start the drill and, as the hone spins, move it up and down at the lower end of the cylinder. The cylinder is not worn at the bottom but is round so it will act to guide the hone and straighten the cylinder bore. As the bottom of the cylinder increases in diameter, gradually increase your strokes until the hone travels the full length of the bore.

NOTE: *Do not extend the hone more than ¾ in. to 1 in. past either end of the cylinder bore.*

8. As the cutting tension decreases, stop the hone and tighten the adjusting knob. Check the cylinder bore frequently with an accurate micrometer. Hone 0.0005 in. oversize to allow for shrinkage when the cylinder cools.

9. When the cylinder is within 0.0015 in. of the desired size, change from the rough stone to a finishing stone.

The finished resized cylinder should have a cross-hatched appearance. Proper stones, lubrication, and spindle speed along with rapid movement of the hone within the cylinder during the last few strokes, will produce this finish. Cross-hatching provides proper lubrication and ring break-in.



Cross hatch pattern after honing

NOTE: *It is EXTREMELY important that the cylinder be thoroughly cleaned after honing to eliminate ALL grit. Wash the cylinder carefully in a solvent such as kerosene. The cylinder bore should be cleaned with a brush, soap, and water.*

Cylinder Bore Specifications

Basic Engine Model or Series	Std. Bore Size Diameter	
	Max	Min
Aluminum Cylinder		
6B		
60000 before Ser. #5810060	2.3125	2.3115
60000 after Ser. #5810030	2.375	2.374
8B, 80000, 82000	2.375	2.374
92000	2.5625	2.5615
100000	2.500	2.449
110000	2.7812	2.7802
130000	2.5625	2.5615
Cast Iron Cylinder		
5, 6, 5S, N	2.000	1.999
8	2.250	2.249
9	2.250	2.249
14	2.625	2.624

Bearings

INSPECTION

Plain Type

Bearings should be replaced if they are scored or if a plug gauge will enter. Try the gauge at several points in the bearing.

REPLACING PLAIN BEARINGS

Models 9-14

The crankcase cover bearing support should be replaced if the bearing is worn or scored.

REPLACING THE MAGNETO BEARING

Aluminum Cylinder Engines

There are no removable bearings in these engines. The cylinder must be reamed out so a replacement bushing can be installed.

1. Place a pilot guide bushing in the sump

bearing, with the flange of the guide bushing toward the inside of the sump.

2. Assemble the sump on the cylinder. Make sure that the pilot guide bushing does not fall out of place.

3. Place the guide bushing into the oil seal recess in the cylinder. This guide bushing will center the counterbore reamer even though the oil bearing surface might be badly worn.

4. Place the counterbore reamer on the pilot and insert them into the cylinder until the tip of the pilot enters the pilot guide bushing in the sump.

5. Turn the reamer clockwise with a steady, even pressure until it is completely through the bearing. Lubricate the reamer with kerosene or any other suitable solvent.

NOTE: *Counterbore reaming may be performed without any lubrication. However, clean off shavings because aluminum material builds up on the reamer flutes causing eventual damage to the reamer and an oversize counterbore.*

6. Remove the sump and pull the reamer out without backing it through the bearing. Clean out the remaining chips. Remove the guide bushing from the oil seal recess.

7. Hold the new bushing against the outer end of the reamed out bearing, with the notch in the bushing aligned with the notch in the cylinder. Note the position of the split in the bushing. At a point in the outer edge of the reamed out bearing opposite to the split in the bushing, make a notch in the cylinder hub at a 45° angle to the bearing surface. Use a chisel or a screwdriver and hammer.

8. Press in the new bushing, being careful to align the oil notches with the driver and the support until the outer end of the bushing is flush with the end of the reamed cylinder hub.

9. With a blunt chisel or screwdriver, drive a portion of the bushing into the notch previously made in the cylinder. This is called staking and is done to prevent the bushing from turning.

10. Reassemble the sump to the cylinder with the pilot guide bushing in the sump bearing.

11. Place a finishing reamer on the pilot and insert the pilot into the cylinder bearing until the tip of the pilot enters the pilot guide bushings in the sump bearing.

12. Lubricate the reamer with kerosene, fuel oil, or other suitable solvent, then ream the bushing, turning the reamer clockwise with a steady even pressure until the reamer is completely through the bearing. Improper lubricants will produce a rough bearing surface.

13. Remove the sump, reamer, and the pilot guide bushing. Clean out all reaming chips.

Crankshaft Bearing Specifications

Basic Engine Model or Series	PTO Bearing	Bearing Magneto
Aluminum Cylinder		
6B, 8B	.878	.878
60000, 80000	.878	.878
82000, 92000, 110900	.878	.878
100000, 130000	1.003	.878
Cast Iron Cylinder		
5, 6, N	.878	.878
9	.988	.988
14	1.185	1.185

REPLACING THE P.T.O. BEARING

Aluminum Cylinder Engines

The sump or crankcase bearing is repaired the same way as the magneto end bearing. Make sure to complete repair of one bearing before starting to repair the other. Press in new oil seals when bearing repair is completed.

NOTE: *On Models 8B-HA, 80590, 81590, 82590, 80790, 81790, 82990, 92590, 92990, the magneto bearing can be replaced as described above. However, if the sump bearing is worn, the sump must be replaced.*

REPLACING OIL SEALS

Note the following points:

1. Assemble the seal with the sharp edge of leather or rubber toward the inside of the engine.

2. Lubricate the inside diameter of the seal with "Lubriplate" or equivalent.

3. Press all seals but those listed below so they are flush with the hub. On models 60000, 80000, 100000, and 13000 with ball bearing which has a mounting flange, the seal must be pressed in until it is $^3/_{16}$ in. below the crankcase mounting flange.

LUBRICATION

The primary purpose of oil is, of course, lubrication. However oil performs three other very important functions as well: cooling, cleaning, and sealing. Oil absorbs and dissipates heat created by combustion and friction. Oil cleans by trapping and holding dirt and by-products of combustion. This dirt is held in suspension by the oil until it is drained. Oil seals the com-

bustion chamber by coating the rings, thus helping increase and maintain compression.

Briggs and Stratton engines are lubricated with a gear driven splash oil slinger or a connecting rod dipper.

Extended Oil Filler Tubes and Dipsticks

When installing the extended oil fill and dipstick assembly, the tube must be installed so the O-ring seal is firmly compressed. To do so, push the tube downward toward the sump, then tighten the blower housing screw, which is used to secure the tube and bracket. When the dipstick assembly is fully depressed, it seals the upper end of the tube.

A leak at the seal between the tube and the sump, or at the seal at the upper end of the dipstick can result in a loss of crankcase vacuum, and a discharge of smoke through the exhaust system.

Breathers

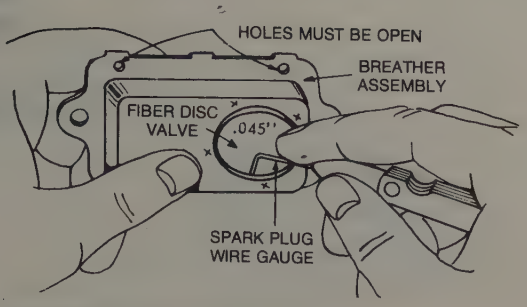
The function of the breather is to maintain a vacuum in the crankcase. The breather has a fiber disc valve which limits the direction of air flow caused by the piston moving back and forth in the cylinder. Air can flow out of the crankcase, but the one-way valve blocks the return flow, thus maintaining a vacuum in the crankcase. A partial vacuum must be maintained in the crankcase to prevent oil from being forced out of the engine at the piston rings, oil seals, breaker plunger, and gaskets.

INSPECTION OF THE BREATHER

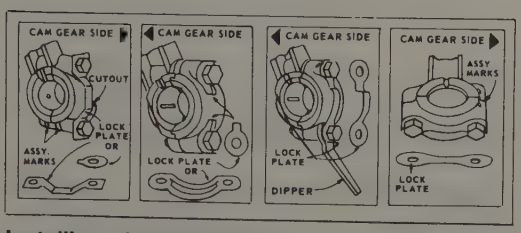
If the fiber disc valve is stuck or binding, the breather cannot function properly and must be replaced. A 0.045 in. wire gauge should not enter the space between the fiber disc valve and the body. Use a spark plug wire gauge to check the valve. The fiber disc valve is held in place by an internal bracket which will be distorted if pressure is applied to the fiber disc valve. Therefore, do not apply force when checking the valve with the wire gauge.

If the breather is removed for inspection or valve repair, a new gasket should be used when replacing the breather. Tighten the screws securely to prevent oil leakage.

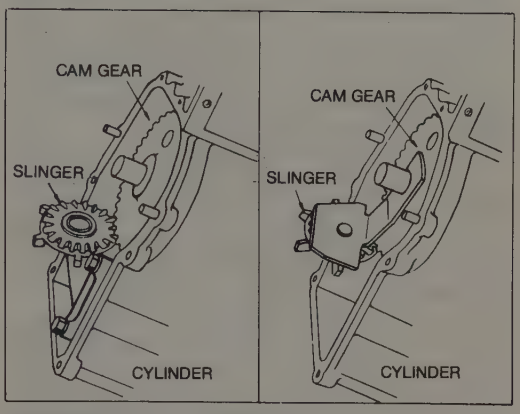
Most breathers are now vented through the air cleaner, to prevent dirt from entering the crankcase. Check to be sure that the venting elbows or the tube are not damaged and that they are properly sealed.



Checking the breather assembly



Installing the connecting rod in a horizontal crankshaft engine



Installation of an oil slinger

Oil Dippers and Slingers

Oil dippers reach into the oil reservoir in the base of the engine and splash oil onto the internal engine parts. The oil dipper is installed on the connecting rod and has no pump or moving parts.

Oil slingers are driven by the cam gear. Old style slingers using a die cast bracket assembly have a steel bushing between the slinger and the bracket. Replace the bracket on which the oil slinger rides if it is worn to a diameter of 0.490 in. or less. Replace the steel bushing if it is worn. Newer style oil slingers have a stamped steel bracket.

5
Clinton

ENGINE IDENTIFICATION

Clinton engines are identified by a name plate that is installed on the engine at the factory. The name plate contains the serial number and the model number, both of which are necessary when obtaining replacement parts.

Two numbering systems are used to identify Clinton engines. The first one applies to engines made prior to 1961, the second pertains to engines made after that year.

The early numbering system has no practical use to the consumer. It is useful only when ordering parts and only to one who has access to a parts manual. No other information can be gained from the model or serial number than what parts fit a particular engine.

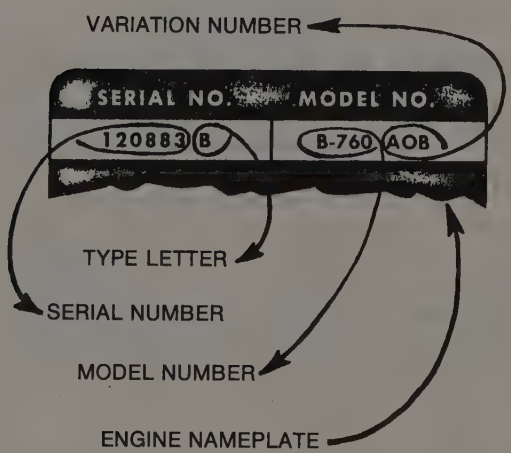
The recent numbering system, however, is quite useful in gaining additional information about a certain engine. The serial number, followed by the type letter, is a numerically sequential number and is used to identify the engine in relation to changes that are made in design. The model number consists of a ten digit sequence of numbers that is deciphered in the following manner:

The first digit indicates whether the engine is a two stroke or four stroke design. The number 4 indicates a four stroke engine and the number 5 indicates a two stroke engine.

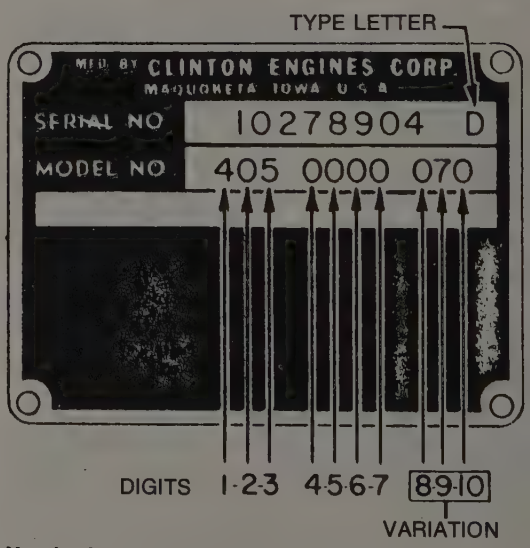
The second and third digits identify the basic engine series and whether the engine has a vertical or horizontal crankshaft. Odd numbers in the third digit position indicate that the engine has a vertical crankshaft and even numbers indicate a horizontal crankshaft.

The fourth digit identifies the type of starter installed on the engine: 0—a recoil starter, 1—a rope starter, 2—an impulse starter, 3—a crank starter, 4—a 12 volt electric starter, 5—a 12 volt starter generator, 6—a 110 volt electric starter, 7—a 12 volt generator, 8—not assigned any specific meaning, 9—indicates a short block.

The fifth digit indicates what type of bearing is used on the crankshaft; 1—aluminum or



Prior to 1961 engine numbering system



Numbering system after 1961

bronze sleeve bearing with a flange mounting surface and pilot diameter on the engine mounting face for mounting equipment concentric to the crankshaft center line; 2—ball or roller bearing; 3—ball or roller bearing with a flange mounting surface and pilot diameter on the engine mounting face for mounting equipment concentric to the crankshaft center line; 4 thru 9—not assigned any meaning.

The sixth digit identifies whether there are any reduction gears or power-take-off units: 0—not equipped with any such unit; 1—auxiliary PTO; 2—2:1 reduction gears; 3—not assigned; 4—4:1 reduction gears; 5—not assigned; 6—6:1 reduction gears; 7 thru 9—not assigned.

The eighth through tenth digits are used to identify model variations.

The type letter identifies parts that are not interchangeable.

Be sure to give the model number and the type letter when obtaining replacement parts.

MAINTENANCE

Air Cleaner Service

METALLIC MESH AIR CLEANER

1. Loosen the air cleaner screw and remove the air cleaner.
2. Place both element and cover parts in a nonvolatile solvent, and agitate the metal mesh vigorously.
3. Dip the mesh into clean engine oil, and then install air cleaner.

DRY PAPER AIR CLEANER

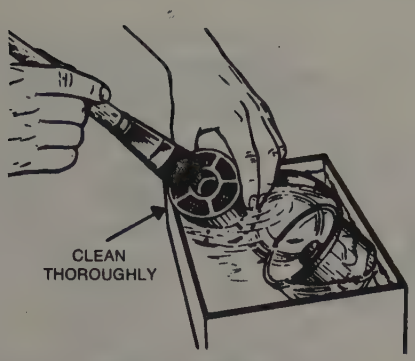
1. Remove the air cleaner can from the engine.
2. Brush lightly with a soft bristle brush (not a wire brush).
3. Blow the dirt out, using compressed air. Blow from inside to outside.
4. Make sure the sealing gasket is in place, and install the air cleaner.

OIL BATH AIR CLEANER

1. Remove the air cleaner from the engine, disassemble, and soak in a nonvolatile solvent.
2. Inspect the plastic blow carefully for cracks, and replace if necessary.
3. Blow the solvent out of the mesh filter with compressed air.
4. Fill to the correct level with SAE 30 oil, and install.

POLYURETHANE AIR CLEANER

1. Remove the element from the air cleaner container, and wash it in soap and water.



Oil bath air cleaner—washing mesh in solvent

2. Dry it thoroughly. Apply enough engine oil to cover the face of the element (about 1 tablespoon), and install the air cleaner.

Oil and Fuel Recommendations

FOUR-CYCLE OIL

Follow the recommendations below. *Do not* use oil of ML (Mostly Light) rating, as it will void the warranty. MM oil is recommended, but best results are obtained with MS rated oil. Oil rated DG may be used, but is not particularly recommended, and DM oil is specifically *not* recommended. Its use will void the warranty.

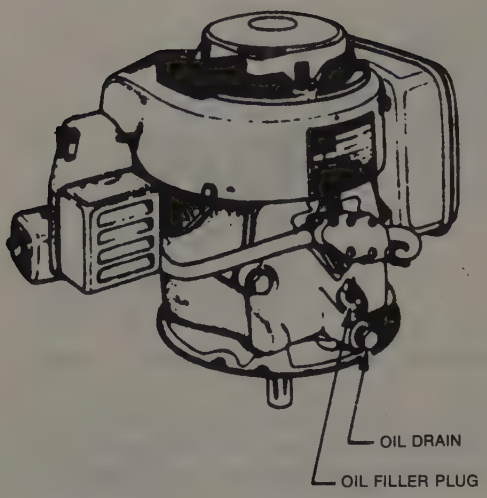
- 32 degrees F and above: SAE 30, MM or MS
- 10 degrees F—32 degrees F: SAE 10W, MM or MS
- Below -10 degrees F: SAE 5W, MM or MS rating

TWO-CYCLE OIL

Use a good quality outboard (two—stroke) motor oil, rated MM or MS. Do not use oils

Crankcase Capacity Chart

Model	Capacity
V-100, VS-100, A-300, A-650, VS-2100, VS-3100, VS-4100, and Models 401, 403, 405, 407, 408, 409, 411, 415, 417, 429, 431, 435	1 pint
100, 2100, 3100, H-3100, 4100, 400, 402, 404, 406, 424, 426	1¼ pints
700-A, 700-C, D-700, D-800, A-800, A-900, A-1100, B-1100, C-1100, D-1100, D-1200, A-1200, B-1290, 492, 494, 498	1¼ pints
VS-700, VS-750, VS-800, VS-900, V-1000, V-1100, VS-1100, V-1200, VS-1200, 499	¼ pints
429, 431, 435	1¾ pints



VS-700

V-100 crankcase fill and drain points

rated DM or DS. Use SEA 30 or SAE 40 viscosity.

On sleeve bearing engines, mix the oil in the proportions: ¾ pint to each gallon of gasoline. On needle bearing engines, use ½ pint to each gallon of gasoline.

NOTE: *On outboard motors, during the first five hours of operation (break-in), mix ½ pint of oil to each gallon of gasoline. After that, mix ¼ pint to each gallon of fuel. Mix the oil and fuel thoroughly by first supplying one gallon of fuel, pouring the oil in and shaking the can vigorously, and then completely filling the fuel can.*

NOTE: *When the engine uses a screw-in type dipstick, check oil level without screwing dipstick into crankcase.*

TUNE-UP

Spark Plugs

Remove the spark plug lead and remove the spark plug with a deep well socket. Check for excessive buildup of carbon deposits, burned electrodes, and a cracked insulator. Replace the plug if any of these problems exist. If the plug has only light carbon deposits, wire brush the plug clean and set plug gap with a wire feeler gauge to: .028–.033 in. on 2-cycle engines; .025–.028 in. on 4-cycle engines.

Breaker Points

CHECKING

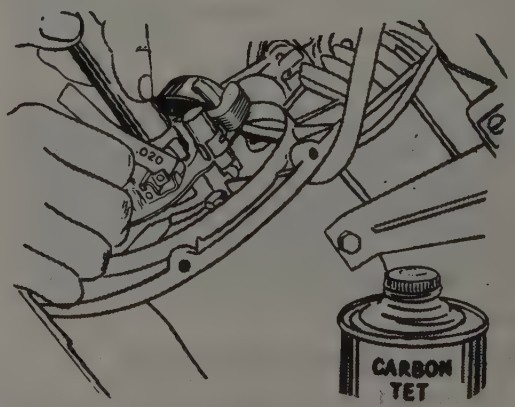
1. To check the breaker points, remove the ball, the magneto box cover, and gasket.
2. Look for evidence of excess oil in the box, which would indicate a leaking oil seal or defective breather assembly.
3. Check the point contacts for excessive wear or pitting. Normally the point assembly will last for many years if it is aligned properly, the gap is set correctly, and the rubbing block or shuttle is properly aligned on the actuating cam. If it is necessary to replace the points, make sure tht the new set is installed properly.

NOTE: *Do not file the points and bend only the stationary side of the points to align the contact surfaces. Replace the condenser when the points are replaced.*

4. Breaker point gap is critical to engine performance, so make sure it is set to .020 in. unless otherwise specified on the bail cover.

REPLACEMENT

1. Remove the flywheel, as described in the "Engine Disassembly" procedure. Remove the bail and remove the breaker box cover and gasket.



Checking the breaker point gap

General Engine Specifications

Model Number	Block Construction	Piston Displacement	Type
E65	Alum.	5.76	2 Cycle
100	Alum.	7.2	4 Cycle
100-1000	Alum.	7.2	4 Cycle
100-2000	Alum.	7.2	4 Cycle
V100-1000	LLCI	7.2	4 Cycle
VS100	Alum.	7.2	4 Cycle
VS100-1000	Alum.	7.2	4 Cycle
VS100-2000	Alum.	7.2	4 Cycle
VS100-3000	Alum.	7.2	4 Cycle
VS100-4000	Alum.	7.2	4 Cycle
200	Alum.	4.5	2 Cycle
A200	Alum.	4.5	2 Cycle
AVS200	Alum.	4.5	2 Cycle
AVS200-1000	Alum.	4.5	2 Cycle
VS200	Alum.	4.5	2 Cycle
VS200-1000	Alum.	4.5	2 Cycle
VS200-2000	Alum.	4.5	2 Cycle
VS200-3000	Alum.	4.5	2 Cycle
VS200-4000	Alum.	5.76	2 Cycle
300	LLCI	4.72	4 Cycle
A300	LLCI	4.72	4 Cycle
VS300	LLCI	4.72	4 Cycle
350	LLCI	4.72	4 Cycle
A400	Alum.	5.76	2 Cycle
A400-1000	Alum.	5.76	2 Cycle
AVS400	Alum.	5.76	2 Cycle
AVS400-1000	Alum.	5.76	2 Cycle
BVS400	Alum.	5.76	2 Cycle
CVS400-1000	Alum.	5.76	2 Cycle
VS400	Alum.	5.76	2 Cycle
VS400-1000	Alum.	5.76	2 Cycle
VS400-2000	Alum.	5.76	2 Cycle
VS400-3000	Alum.	5.76	2 Cycle
VS400-4000	Alum.	5.76	2 Cycle
500	LLCI	5.89	4 Cycle
GK590	Alum.	5.76	2 Cycle
650	LLCI	5.89	4 Cycle
700-A	LLCI	5.89	4 Cycle
B700	LLCI	5.89	4 Cycle
C700	LLCI	5.89	4 Cycle
D700	LLCI	6.65	4 Cycle
D700-1000	LLCI	6.65	4 Cycle
D700-2000	LLCI	6.65	4 Cycle
D700-3000	LLCI	6.65	4 Cycle
VS700	LLCI	5.89	4 Cycle
VS750	LLCI	5.89	4 Cycle
800	LLCI	8.3	4 Cycle
A800	LLCI	8.3	4 Cycle
VS800	LLCI	8.3	4 Cycle
900	LLCI	8.3	4 Cycle
900-1000	LLCI	8.3	4 Cycle
900-2000	LLCI	8.3	4 Cycle
900-3000	LLCI	8.3	4 Cycle
900-4000	LLCI	8.3	4 Cycle
VS900	LLCI	8.3	4 Cycle
V1000-1000	LLCI	8.3	4 Cycle
VS1000	LLCI	8.3	4 Cycle
A & B 1100	LLCI	8.3	4 Cycle
C1100	LLCI	8.3	4 Cycle
D1100	LLCI	8.3	4 Cycle
V1100-1000	LLCI	9.5	4 Cycle
VS1100	LLCI	9.5	4 Cycle
VS1100-1000	LLCI	9.5	4 Cycle
1200	LLCI	10.2	4 Cycle
1200-1000	LLCI	10.2	4 Cycle
1200-2000	LLCI	10.2	4 Cycle
A1200	LLCI	10.2	4 Cycle
B1290-1000	LLCI	10.2	4 Cycle
V1200-1000	LLCI	10.2	4 Cycle
VS1200	LLCI	10.2	4 Cycle
2100	Alum.	7.2	4 Cycle
A2100	Alum.	7.2	4 Cycle
A2100-1000	Alum.	7.2	4 Cycle
A2100-2000	Alum.	7.2	4 Cycle
VS2100	Alum.	7.2	4 Cycle
VS2100-1000	Alum.	7.2	4 Cycle
VS2100-2000	Alum.	7.2	4 Cycle
VS2100-3000	Alum.	7.2	4 Cycle
VS3000	Alum.	7.2	4 Cycle
3100	Alum.	8.3	4 Cycle
3100-1000	Alum.	8.3	4 Cycle
3100-2000	Alum.	8.3	4 Cycle
3100-3000	Alum.	8.3	4 Cycle
H3100-1000	LLCI	8.3	4 Cycle
FV3100-1000	LLCI	8.3	4 Cycle
AFV3100-1000	LLCI	8.3	4 Cycle
AV3100-1000	LLCI	8.3	4 Cycle
AV3100-2000	LLCI	8.3	4 Cycle
AVS3100	Alum.	8.3	4 Cycle
AVS3100-1000	Alum.	8.3	4 Cycle
AVS3100-2000	Alum.	8.3	4 Cycle
AVS3100-3000	Alum.	8.3	4 Cycle
V3100-1000	LLCI	8.3	4 Cycle
V3100-2000	LLCI	8.3	4 Cycle
VS3100	Alum.	8.3	4 Cycle
VS3100-1000	Alum.	8.3	4 Cycle
VS3100-2000	Alum.	8.3	4 Cycle
VS3100-3000	Alum.	8.3	4 Cycle
4100	Alum.	8.3	4 Cycle
4100-1000	Alum.	8.3	4 Cycle
4100-2000	Alum.	8.3	4 Cycle
AVS4100-1000	Alum.	8.3	4 Cycle
AVS4100-2000	Alum.	8.3	4 Cycle
VS4100-1000	Alum.	8.3	4 Cycle
VS4100-2000	Alum.	8.3	4 Cycle
400-0000-000	Alum.	7.2	4 Cycle
401-0000-000	Alum.	7.2	4 Cycle
402-0000-000	Alum.	7.2	4 Cycle
403-0000-000	Alum.	7.2	4 Cycle
404-0000-000	Alum.	8.3	4 Cycle
405-0000-000	Alum.	8.3	4 Cycle
406-0000-000	LLCI	8.3	4 Cycle
407-0000-000	LLCI	8.3	4 Cycle
407-0002-000	LLCI	8.3	4 Cycle
408-0000-000	Alum.	8.3	4 Cycle
409-0000-000	Alum.	8.3	4 Cycle

General Engine Specifications

Model Number	Block Construction	Piston Displacement	Type	Model Number	Block Construction	Piston Displacement	Type
411-0000-000	Alum.	7.2	4 Cycle	492-0300-000	LLCI	8.3	4 Cycle
411-0002-000	Alum.	7.2	4 Cycle	494-0000-000	LLCI	8.3	4 Cycle
415-0000-000	Alum.	8.3	4 Cycle	494-0001-000	LLCI	8.3	4 Cycle
415-0002-000	Alum.	8.3	4 Cycle	497-0000-000	LLCI	10.2	4 Cycle
417-0000-000	LLCI	8.3	4 Cycle	498-0300-000	LLCI	10.2	4 Cycle
424-0000-000	LLCI	8.3	4 Cycle	498-0301-000	LLCI	10.2	4 Cycle
426-0000-000	Alum.	8.3	4 Cycle	499-0000-000	LLCI	10.2	4 Cycle
429-0003-000	LLCI	9.2	4 Cycle	500-0000-000	Alum.	5.76	2 Cycle
431-0003-000	LLCI	9.2	4 Cycle	501-0000-000	Alum.	5.76	2 Cycle
435-0003-000	Alum.	8.3	4 Cycle	501-0001-000	Alum.	5.76	2 Cycle

Alum. = Aluminum
LLCI = Long Life Cast Iron

2. Disconnect the primary wire, remove the contact set attaching screws, and remove the contacts.

3. Reverse the removal procedure to install the contact set. Leave the contact set mounting screws slightly loose.

4. Rotate the crankshaft until the points are on the highest point of the cam. Set the gap to the specification shown on the bail cover, or to .020 in. using a flat feeler gauge, as shown. Tighten the mounting screws.

5. Clean the contact surfaces with carbon tetrachloride and then dry with paper. Align the surfaces, if necessary, as described above under "Checking." Reset the gap, if necessary.

6. Grease the cam, rotate the crankshaft, and then remove the excess grease.

7. Replace the cover gasket if it is damaged or oil soaked. Install the cover and snap the bail into position.

8. Install the flywheel, and torque the nut to specification.

Magneto Air Gap

The magneto air gap is the distance between the stationary laminations of the coil and the rotating magnets of the flywheel. In general, the closer the magnets pass to the laminations, the better the magneto will perform. Some extra clearance must be provided for bearing wear, however. The proper clearance for engines under five horsepower is 0.007 in. to 0.017 in. and 0.012 in. to 0.020 in. for engines over five horsepower.

The air gap is measured by placing layers of plastic tape over the laminations, replacing the flywheel and turning the flywheel. Remove the flywheel and check to see if the flywheel touched the tape, and adjust the coil assembly accordingly. Use only one layer of tape at a time. The thickness of common plastic electrician's tape is about 0.008 to 0.009 in.

Breaker Cam

The breaker cam on most Clinton engines is replaceable. Check the fit of the cam over the crankshaft to make sure that it is tight.

Mixture Adjustment

1. If the engine runs very roughly or will not start, first make a preliminary setting as follows:

a. *Very gently* turn the main mixture screw in until it seats *very lightly*.

b. Turn screw outward (counterclockwise) the specified number of turns:

- 501—1 turn
- Lift Carburetors—1¼-1½ turns
- LMG, LMB, LMV Carburetors—1¼
- All others—1½ turns

2. Following this, start and run the engine until hot. Then, turn the mixture screw inward or outward in 1/16 turn increments, pausing after each adjustment, until best running is obtained. The most accurate adjustment is obtained with a tachometer. Set the mixture so the highest possible rpm is obtained.

Mechanical Govenor Adjustment

1. Stop the engine and set any throttle controls so there is tension on the governor spring.

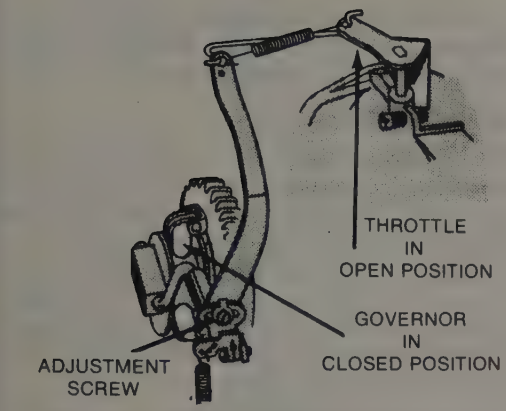
2. Loosen the adjusting screw. Position the throttle to within exactly 1/32 in. of the stop on the carburetor casting. Tighten the adjusting screw.

Compression Check

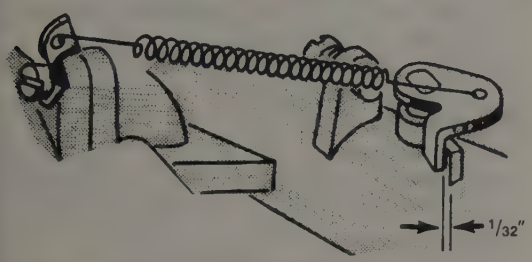
1. Remove the spark plug and install a compression gauge in its place.

2. Crank the engine over at normal cranking speed. Gauge readings should be:

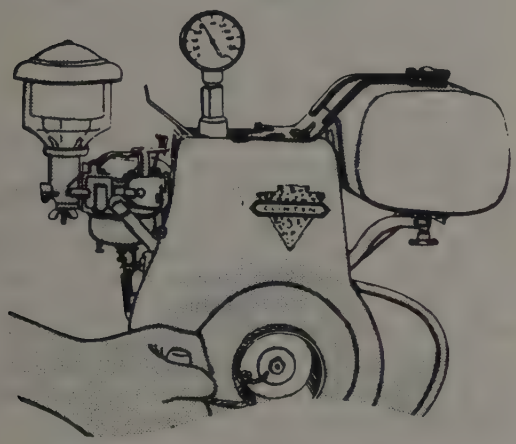
- 2-stroke: above 60 psi
- 4-stroke up to 4½ hp.: 65–70 psi
- 4-stroke above 4½ hp.: 70 psi



Location of governor adjustment screw



Throttle position and dimension



Checking compression

FUEL SYSTEM

Carburetor

Clinton engines use a variety of float type carburetors and one type of suction lift carburetor.

A carburetor can only malfunction as a result of these causes: the presence of foreign matter (dirt, water); out of adjustment (too rich or too lean a mixture), and leakage caused by worn parts or cracks in the casting. Look for any of the above causes before disassembling the carburetor. Of course, it may be required that the carburetor be disassembled to correct the problem, but at least you will have some direction.

NOTE: *Check the throttle shaft/main casting tolerance. This is one place on the carburetor that cannot be repaired.*

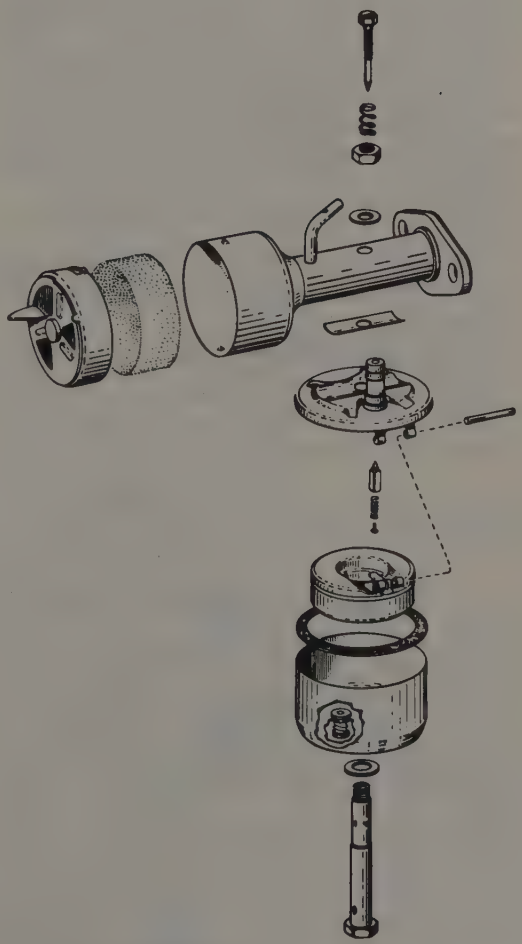
501 ENGINE CARBURETOR

The 501 engine carburetor is a relatively simple carburetor and can be disassembled after it is removed from the engine.

1. Remove the choke and air filter assembly, remove the mixture adjusting screw and spring, and unscrew the large bolt which holds the float bowl to the rest of the carburetor.

2. Please note that the main fuel nozzle is contained in the top of the large bolt and care should be exercised not to damage the needle seat. Disassemble the float and fuel inlet needle.

NOTE: *The needle seat is not replaceable. The bowl cover, needle pin, spring, and seat assembly must be replaced if any part is worn.*



501 Engine carburetor

3. Clean all parts in solvent, blow dry with compressed air, inspect, and replace any worn or damaged parts.

4. Assemble the carburetor in the reverse order of disassembly. Set the float level with the bowl cover inverted and the float and needle installed so that there is 13/64 in. plus or minus 1/32 in. clearance between the outer edge of the bowl cover and the free end of the float. Adjust the level by bending the lip of the float with a screwdriver. *Use all new gaskets.*

5. Set the mixture adjusting needle one turn open from the seat to start the engine. This carburetor does not have an idle mixture orifice and therefore will not operate at speeds below 3000 engine rpm. The operating range is between 3000 and 3800 rpm. Make the final mixture adjustment with a tachometer if possible. If a tachometer is not available, adjust the mixture screw 1/16 of a turn at a time until you obtain the best engine performance.

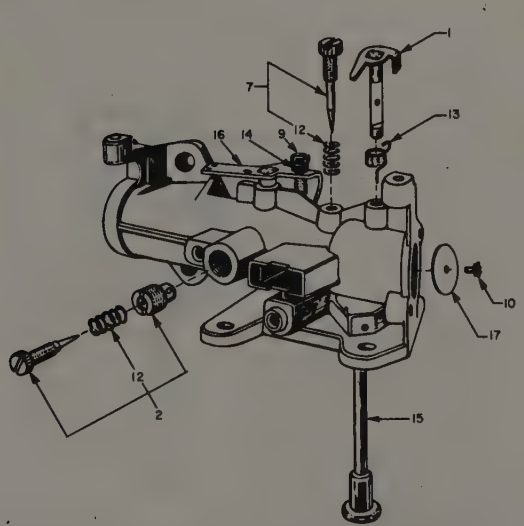
SUCTION LIFT CARBURETOR

Throttle Plate and Shaft Replacement

1. Drill through the plug at the rear of the carburetor body.
2. Force out the plug with a small drift pin.
3. Remove the plastic plug.
4. Remove the screws which retain the throttle plate to the shaft and remove the plate and shaft.
5. Reinstall in the reverse order of removal.

Make sure that the throttle plate and shaft operate without binding. Use a sealer on the new expansion plug.

NOTE: *Horizontal suction lift carburetors do not have a plug.*



Suction lift carburetor

The choke plate and shaft is replaced in the same manner as the throttle, except that there is no expansion plug to be removed.

Stand Pipe Replacement

The stand pipe is press-fit into the body of the carburetor. Remove the pipe by clamping it in a vise and twisting the carburetor body while at the same time pulling until the pipe is free. To install the pipe, tap it lightly into place until the end of the pipe is 1.94 in. ±0.45 in. from the body of the carburetor. Use a sealer at the point where the pipe is inserted into the carburetor body.

Idle Needle and Jet Replacement

The idle needle and jet are replaceable and can be removed as follows:

1. Unscrew the needle and remove it.
2. Remove the expansion plug in the bottom of the carburetor body.
3. To remove the idle jet, push a piece of 1/16 in. diameter rod through the fuel well and up the idle passage until the jet is pushed out of the passage.

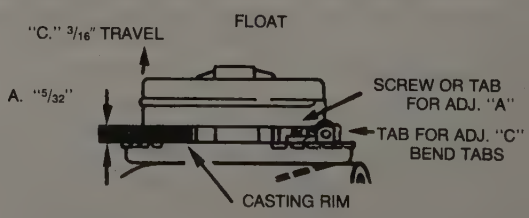
To install the idle needle and jet:

4. Make a mark exactly 1¼ in. from the end of the 1/16 in. diameter rod and push the new jet into the idle passage until the mark is exactly in the center of the main fuel well.
5. Install the needle and set it at 4 to 4¼ turns open from being seated.

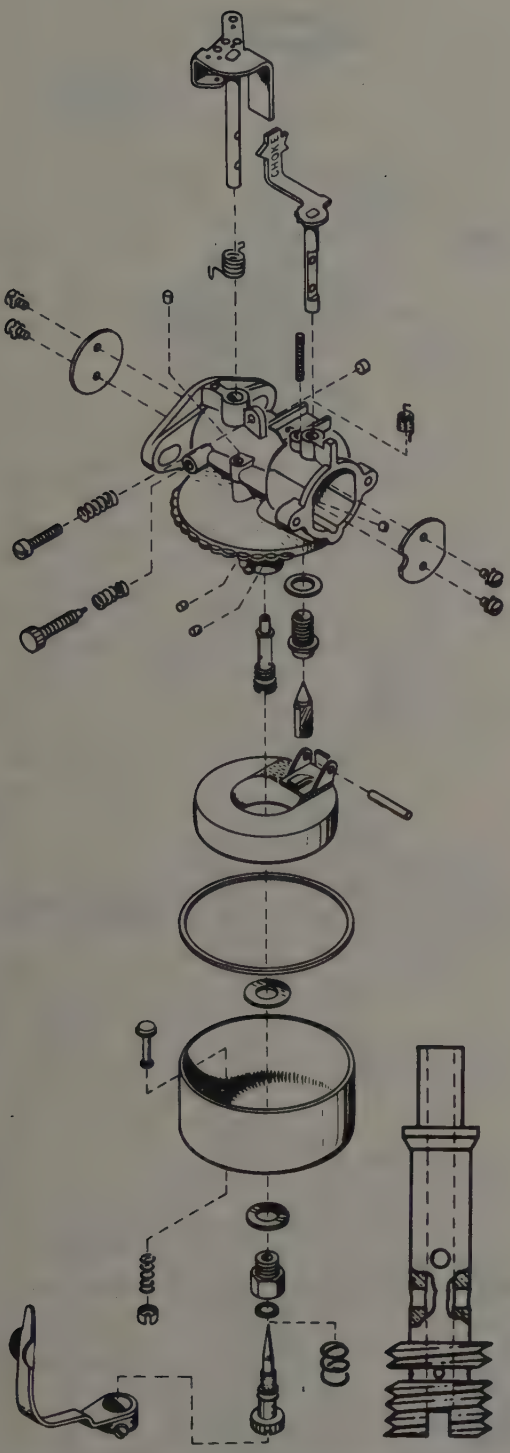
The high speed needle and seat can be inspected for wear or damage by removing the needle and checking its taper. If the needle taper is damaged, replace it. Inspect the seat for taper and splits. If the seat is split or tapered from the needle being screwed in too tight, the complete carburetor must be replaced, since the seat cannot be replaced separately. When the needle is replaced, the initial adjustment is ¾ to 1½ turns open from being *lightly* seated.

LMG, LMB AND LMV TYPE CARBURETORS

These carburetors are float type carburetors and can be reconditioned in the same manner as the 501 carburetors by taking a note of the



Float adjustment for the LMG, LMV, LMB type carburetors



LMG, LMV, LMB type carburetors with an enlarged view of the main jet nozzle

following differences in design and specifications.

The main fuel nozzle needle is inserted from the bottom and pushed up through the middle of the float bowl.

The float, fuel inlet needle, and seat are basically the same as that of the 501 carburetor.

NOTE: *Do not remove the main fuel nozzle from the carburetor body unless it is to be replaced. Once it is removed it cannot be reinstalled.*

Use all new gaskets.

The throttle valve is installed with the part number or trademark 'W' facing toward the mounting flange.

The preliminary setting of the idle adjusting needle is 1¼ turns open after being *lightly* seated.

Adjust the float in the same manner as the 501 carburetor. There should be $^{5}/_{32}$ in. clearance between the float and the casting rim when the carburetor is inverted. When the carburetor is turned over, the float should not drop more than $^{3}/_{16}$ in.

The preliminary setting for the main fuel adjusting needle is 1¼ turns open after being *lightly* seated.

H.E.W. CARBURETORS

H.E.W. carburetors are float type carburetors and can be serviced in the same manner as 501 carburetors. After cleaning and inspecting the parts for wear or damage, assemble the carburetor, noting the following differences:

Install the throttle valve with the part number or 'W' toward the mounting flange with the throttle in the closed position. Always use new gaskets during assembly.

The initial setting for the idle adjusting screw is 1½ turns open from being *lightly* seated.

If any part of the float assembly has to be replaced, replace the whole assembly. Do not replace individual parts.

The float setting is made in the same manner as the 501 carburetor, by turning the main body of the carburetor upside down and measuring the clearance between the float and the body casting rim. The distance in this case is $^{3}/_{16}$ in. with $^{3}/_{16}$ in. of travel.

The preliminary setting for the high speed adjusting screw is 1½ turns open from being seated lightly.

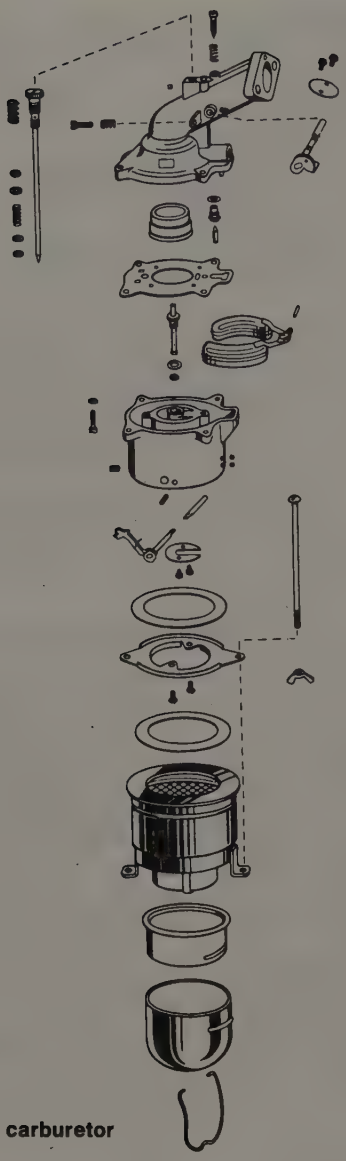
U.T. CARBURETORS

These are also float type carburetors and are serviced in the same manner as 501 carburetors, noting the following differences:

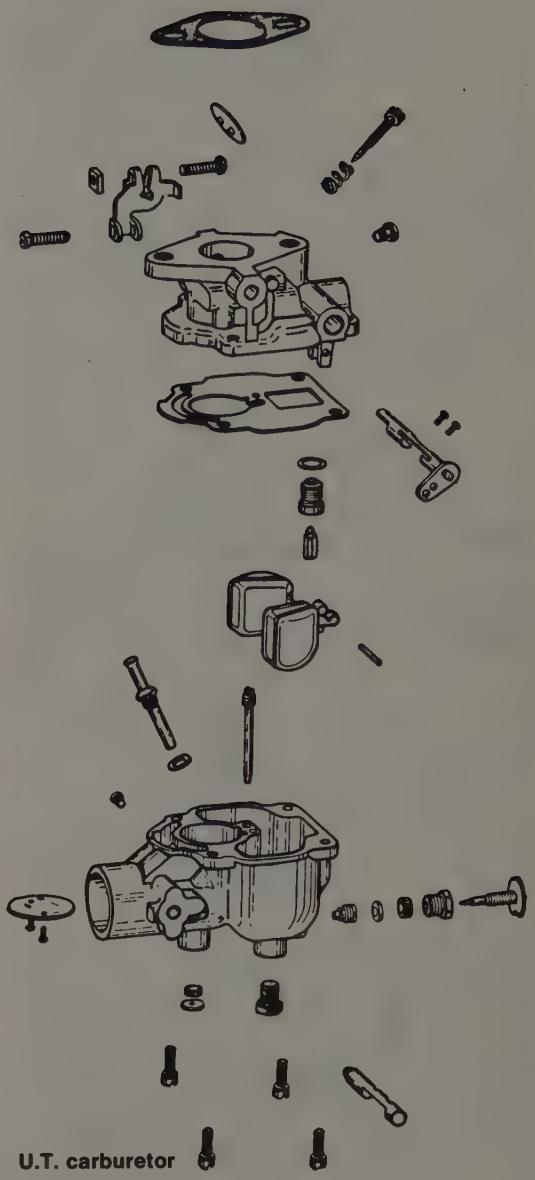
The throttle valve is installed with the trademark 'C' on the side toward the idle port when viewed from the mounting flange side. Use new screws.

Set the float level with the float installed and the housing inverted. The measurement is to be taken with the needle seated and the gasket removed. Measure between the float seam and the throttle body. Adjust by bending the lip of the float.

The preliminary setting for the high speed



H.E.W. carburetor



U.T. carburetor

adjusting needle is 1¼ turns open from being lightly seated.

The preliminary setting for the idle adjusting needle is 1½ turns open from being lightly seated.

The chart below gives the float level setting dimension as related to the carburetor identification number and part number:

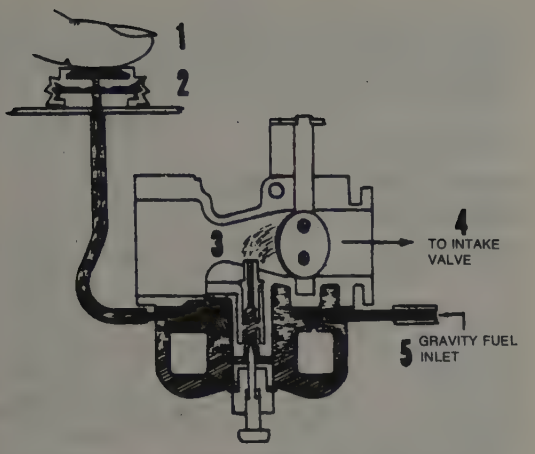
Ident No.	Part No.	Float Setting (in.)
2712-S	39-143-500	19/64
2713-S	39-144-500	19/64
2714-S	39-140-500	1/4
*2398-S	39-147-500	1/4
2336-S	39-146-500	1/4
2336-SA	39-146-500	1/4
2337-S	39-145-500	1/4
2337-SA	39-145-500	1/4
2230-S	39-343-500	17/64
2217-S	39-344-500	11/64

*With resilient seat—9/32 + or − 1/64

TOUCH 'N' START PRIMER CARBURETOR

Steps in operation of the primer:

1. Seal the bowl vent with a finger.
2. Depress the bulb to pressurize the bowl.
3. Pressure in carburetor bowl forces the fuel into the carburetor throat.
4. When the engine is cranked, the intake valve opens, letting gasoline into the combustion chamber for quick starting.
5. Gasoline forced from the bowl during



Operation of Touch 'N' Start primer carburetor

priming is replaced by the flow of gasoline from the fuel tank through the gravity fuel inlet.

This primer is applicable to the LMG, LMB, and LMV carburetors. Servicing this carburetor would be the same as listed for the LMG, LMB, and LMV, except a choke lever and choke valve are not used. Note the bowl atmospheric vent is routed back through the primer tube and bulb.

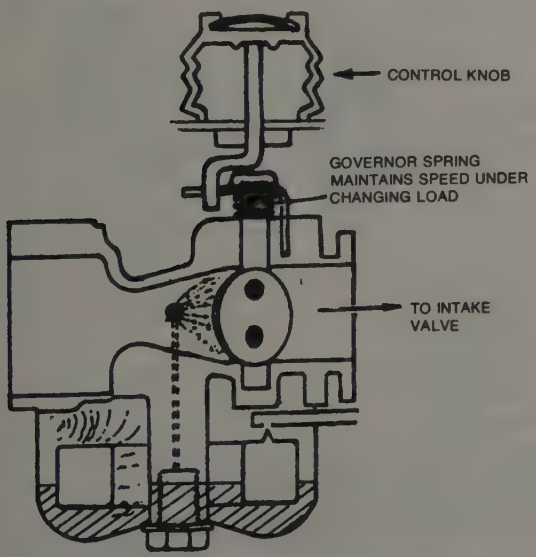
FIXED SPEED CARBURETOR

Steps in operation:

1. Rotate the control knob counterclockwise to open the throttle (4—cycle engines) (2—cycle not equipped with control knob)

2. To stop the engine rotate the control knob clockwise. (4—cycle engines) (2—cycle engines use a shorting device)

NOTE: *The governor spring is located on the throttle shaft between the lever and the carburetor casting. The setting on the high speed screw is 1¼ to 1½ turns. Servicing this carburetor would be the same as listed for the LMG, LMB, or LMV except there is no main nozzle or idle circuit.*



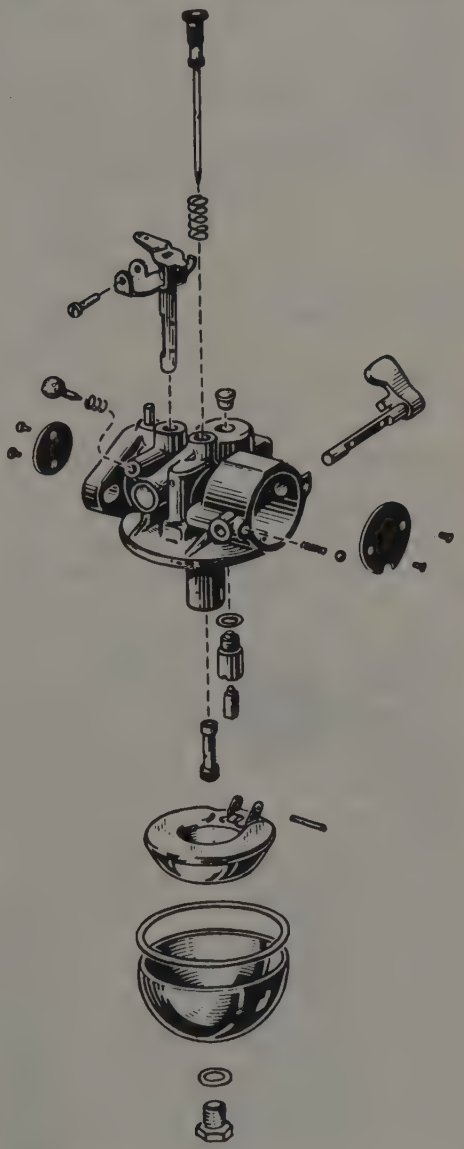
Operation of the Fixed Speed carburetor

CARTER CARBURETORS

Carter float type carburetors are serviced in the same manner as 501 carburetors, taking note of the following differences:

Do not remove the choke valve and shaft unless they are to be replaced. A spring loaded ball holds the choke in the wide open position. Be sure to use a new ball and spring when replacing the choke shaft and plate assembly.

Install the throttle plate with the trademark



Carter carburetor

'C' on the side toward the idle port when viewed from the mounting flange side.

The float setting is made in the same manner as the 501 carburetor and the measurement is $^3/_{16}$ in.

The initial setting for the high speed adjusting screw is 2 turns open from being lightly seated.

The initial adjustment for the idle adjusting screw is 1½ turns open from being lightly seated.

Fuel Pumps

MECHANICAL FUEL PUMPS

These pumps can be rebuilt. See the exploded view below.

The 220–122–500 and 220–145–500 fuel pumps are simple diaphragm units that screw into the inlet side of the carburetor. They are activated by crankcase pressure pulses. They cannot be rebuilt, but must be replaced if they will not lift the fuel six inches.

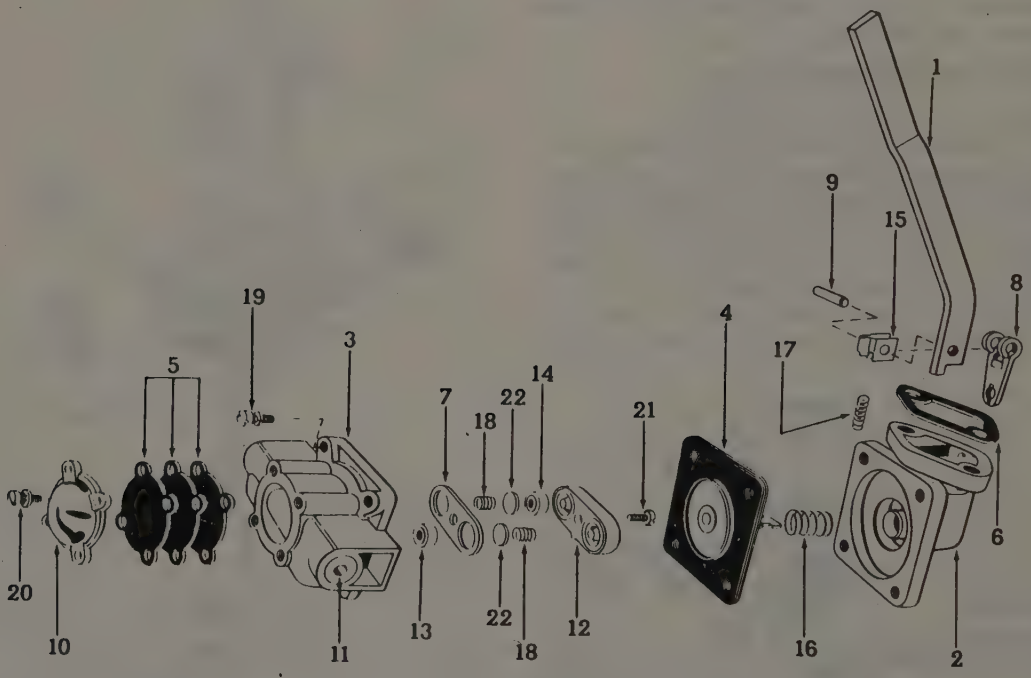
The diaphragm type fuel pumps used on VS-1200, V-1200, and 499 series engines can be rebuilt. However, construction is so simple no rebuild specifics are supplied by the factory.

Governors

INSPECTION AND ASSEMBLY OF MECHANICAL GOVERNOR

When assembling an engine equipped with the centrifugal weight governor inspect the governor shaft bearing in the block and the governor arm assembly that goes through the bearing, for wear and replace them if necessary. After inspection, insert the arm through the bearing and fasten the arm and weight assembly into the bearing.

Care should be taken on installation of this arm and weight assembly as they may be locked to the outside linkage 180 degrees from the correct position which would tear out the centrifugal weights and damage the arm and weight assembly upon operation of the engine. The weight and arm or yoke should be as close to the cam axle or governor gear as it



1. Rocker arm
2. Body
3. Top cover
4. Diaphragm assembly
5. Diaphragm pulsator
6. Mounting gasket
7. Valve gasket
8. Linkage
9. Rocker arm pin
10. Cover plate
11. Pipe plug
12. Valve retainer
13. Valve seat (head)
14. Valve seat (retainer)
15. Rocker arm spring clip
16. Diaphragm spring
17. Rocker arm spring
18. Valve spring
19. Screw & lockwasher assembly (cover plate)
20. Screw & lockwasher assembly (top cover)
21. Screw & lockwasher assembly (valve retainer)
22. Valve

Exploded view of mechanical fuel pump-typical

can be to be properly installed. In this position, it will operate against the governor collar or thimble assembly and will move in conjunction with the governor spring tension and the centrifugal force of the weights which are attached to the camshaft or governor gear.

The collar should be inspected for wear and possible damage, and the weight assembly itself should be inspected for wear and possible damage or bending of the weights or the weight supports.

When servicing a centrifugal governor, check to be certain that the collar or thimble operates freely on the camshaft or governor gear and that the governor shaft moves freely in the bushing. When the bushing in the block is replaced, check carefully freedom of shaft motion as the bushing may be distorted in installation.

Also the governor shaft can be bent easily on disassembly or reassembly and can be bent in usage. Also check range of movement of collar or thimble after assembly of camshaft or governor gear to determine that these parts do not lock against block.

INSPECTION AND ASSEMBLY OF AIR VANE GOVERNOR

The air vane should be inspected visually when reassembling and replaced if bent or damaged. Use care in the hook-up of the air vane link and throttle plate so that they move freely and do not drag at the connections or on the bearing plate or blower housing. Many of the air vane governors have a spring inside of the vane at the pivot. The spring gives a dampening effect on the vane movement. This spring should be replaced if the engine has been out of service for a period of time so that it retains the pressure on the bushing or vane.

When servicing an air vane governor, the condition of the blower housing should be checked carefully. Dents and bends should be removed from it so that the air stream moves as it should to the air vane. The air vane must be in the same condition as when manufactured and replaced when bent because the governor spring tension and the vane are balanced. If the vane does not sit in the air blast properly, the spring will be too strong for the air vane to stretch.

When assembling the air vane governor, apply tension to the governor spring and close the throttle manually to see that it moves open freely, that it does not bind at the governor linkage, air vane, pivot post, bushings, bearing plate, blower housing, etc. It should move freely from closed to open position by governor spring tension.

ENGINE OVERHAUL

The same basic procedure for disassembling a Clinton engine can be used for all engines. The procedure given below pertains to both 2-stroke and 4-stroke Clinton engines; differences are noted. Procedures for servicing individual components are given at a later point in this section.

Engine Disassembly

1. Remove the engine from the piece of equipment it powers and then remove any brackets, braces, adapters or pulleys.
2. Clean the exterior of the engine.
3. Drain the lubricating oil from the crankcase.
4. Remove the fuel tank and blower housing.
5. Remove the carburetor and governor assembly, marking the spring and link holes for correct reassembly.
6. Remove the muffler assembly.
7. Remove the flywheel nut, using a flywheel holder to hold the flywheel while the nut is removed.
8. While lifting up on the flywheel, gently tap the crankshaft to loosen the flywheel from the crankshaft taper. Remove the flywheel and flywheel key.
9. Remove the complete magneto assembly which includes the coil, breaker points, condenser, and laminations.
10. Remove the cylinder head and gasket on 4-stroke envines.
11. Remove the valve chamber cover and breather assembly from 4-stroke engines.
12. Remove the valve spring keepers after compressing the valve spring with a valve spring compressor.
13. Remove the valves and springs from the block after removing the valve spring compressor.

NOTE: *Some valves have a burr on the stem that will prevent the valve from being removed up through the valve guide. If present, it will be necessary to remove this burr from the stem in order to remove the valve from the engine. To remove the burr, hold a flat file against the burred area and rotate the valve.*

14. Remove the base plate or end cover assembly on 4-stroke engines.

NOTE: *On some engines the base is an integral part of the block and cannot be removed. If this is the case, remove the side plate on the power take-off side of the engine. Before removing the side plate or crankshaft, make sure all paint, rust, and*

dirt are cleaned from the area of the crankshaft bearing. This is so the side plate can be easily removed. When removing the side plate from engines that have ball bearings, it will first be necessary to remove the oil seal and the snap-ring from the crankshaft.

15. Remove the mounting plate and reed plate assembly on 2-stroke engines.

16. Remove the connecting rod cap screws and cap. Mark the cap and connecting rod so they can be reassembled in the same position.

17. On 4-stroke engines, check for a carbon or metal ridge at the top of the cylinder. If a ridge is present, remove it with a ridge reamer or hone.

18. On 2-stroke engines, push the piston and connecting rod assembly up into the cylinder as far as it will go so it will not hit the crankshaft when it is removed.

19. Remove the piston and connecting rod assembly from a 4-stroke engine's block.

20. Remove the bearing plate on the flywheel side of the block if the engine being disassembled has one.

21. Remove the crankshaft.

NOTE: *On 4-stroke engines with a ball bearing on the PTO side of the engine, it will be necessary to remove the cap screws which hold the bearing in place before the crankshaft can be removed. On some models with ball bearings and tapered roller bearings, it will be necessary to remove the crankshaft oil seal and camshaft axle, and move the camshaft to one side before the crankshaft can be removed. Two stroke engines having a ball bearing on the PTO side of the crankshaft will have to have the retaining ring, which holds the bearing in place, removed before the crankshaft can be removed.*

22. Remove the camshaft assembly. Drive the camshaft axle out of the PTO side of the block as the flywheel side is smaller.

23. Remove the piston and connecting rod assembly from 2-stroke engines.

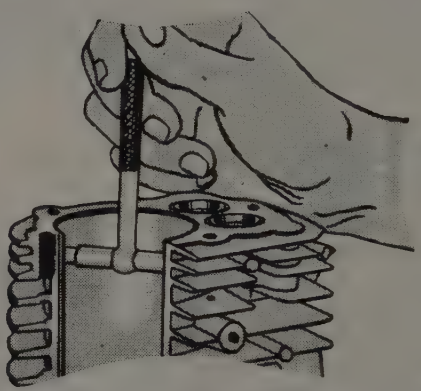
24. After the camshaft is removed from a 4-stroke engine, mark the valve tappets as to whether they are the exhaust tappet or the intake tappet, and then remove them. If no valve work is to be done, be sure to replace the valves in the same position from which they were removed.

25. Remove the piston and rod assembly. After disassembling the engine, clean all parts in a safe solvent, removing all deposits of carbon and oil, etc. Check all operating clearances and replace or rebuild parts as necessary.

Cylinder Bore

After disassembling the engine, inspect the cylinder bore to see if it can be reused. Look for score marks on the cylinder walls. If there are marks and they are too deep to be removed, the block will have to be discarded. If there is a hole in the block due to connecting rod failure, the block will have to be replaced. If there are broken cooling fins on the outside of the block, these can cause overheating and replacing the block should be considered.

Check the dimensions of the cylinder bore to determine the extent of wear and whether or not it has to be rebored. The cylinder bore can be rebored to 0.010 in. or 0.020 in. oversize since there are oversize pistons available in these sizes. If the cylinder is within serviceable limits and there is no need to rebore it, be sure to deglaze the cylinder before installing the piston assembly with new rings.

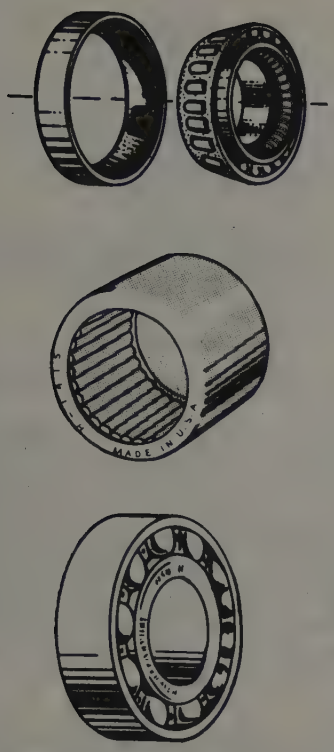


Measuring the cylinder bore—a cutaway view

Bearings

Clinton engines are equipped with tapered roller bearings, ball bearings, needle bearings, and sleeve bearings. The first thing to determine is whether or not the bearing is worn or damaged and needs replacing. Then clean the bearings in a safe solvent, inspect them for excessive play due to wear, smoothness of rotation, pitted surfaces, and damage. All of these types of bearings are pressed on the crankshaft and into the bearing plates and are removed by either a bearing splitter and puller or they are driven out of the bearing plates with a punch. In all cases be very careful not to bend, gouge, or otherwise damage the crankshaft or bearing plate when removing and installing the bearings.

With sleeve bearings, first inspect the bearing surface for scoring and damage to determine whether the bearing has to be replaced. Check the bearing diameter for wear. In some cases you will find that the bearing surface is



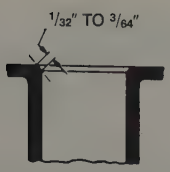
Tapered roller, needle, and ball bearing type bearings, all of which are used in Clinton engines

the same material as the block. These bearings can be reamed out and sleeve bearings installed. If the original bearing is a sleeve type bearing, it can be removed by driving it out with the proper size driving tool. Install the new bearing so that the oil hole in the bearing is aligned with the oil passage in the block or bearing plate. Drive the bearing into the block or bearing plate until it is recessed about 1/32 in. from the crankshaft thrust face of the block or bearing plate. After installing the new piece, it must be finish reamed. After finish reaming, clean all metal filings and debris from the engine, making sure that all oil passages are free from obstruction.

Valve Seats

Standard valve seats, those without inserts, can be reground to remove all of the oxidized surface metal and gain perfect sealing characteristics. After grinding the valve seats, the valves must be lapped in with lapping compound. Not too much lapping is recommended, just enough to obtain a good seal.

If the engine has had a number of valve jobs and the valve seat is too deep, requiring that too much stock be removed from the valve stem to obtain the proper valve-to-tappet clearance, valve seat inserts may be installed. If over half of the metal between the lock



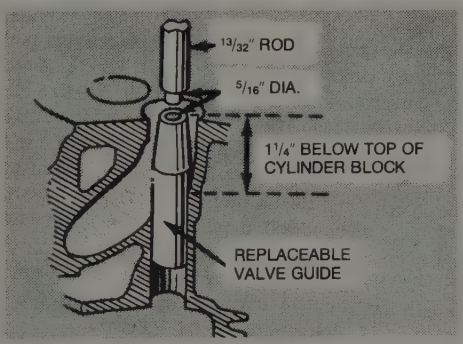
The valve seat width is to be between 1/32 and 3/64 in. (0.030–0.045 in.) and the valve seat angle is to be between 43½° and 44½°

groove and the end of the valve stem has been removed to gain the proper stem-to-tappet clearance, you should consider installing valve seat inserts.

On aluminum block engines, iron valve seat inserts are standard equipment. To remove these inserts, it is first necessary to remove the metal that has been rolled over the edge of the insert to hold it in place. This is normally accomplished by using the proper size cutter. If the valve seat insert is loose, a cutter may not be necessary. After the insert has been removed, it is necessary to cut the block to the proper depth of 3/16 in. to 7/32 in. This is the depth of the insert plus 1/32 in. which is used to hold the insert in place. The insert is held to the cylinder block by a definite interference type press fit. The insert should be cooled before attempting to install it in the block. After the insert is fitted in place, with the bevel facing up, the metal around the edge of the insert must be peened over the edge of the insert in order to hold it in place. Do not strike the block too sharply when peening because of the possibility of distorting the cylinder bore. Finish grind the valve seat insert and lap in the valves.

Valve Guides

First, inspect and measure the valve guide diameter to determine whether the guide is worn enough to necessitate rebuilding. The standard guide size for 4-stroke engines under 5 horsepower is 0.2495–0.2510 in. On engines over 5 horsepower, the standard guide size is 0.312–0.313 in.



Replacing the valve guides

When the valve stem-to-valve guide clearance is more than the maximum serviceable clearance and cannot be corrected by installing a new valve, you will have to either replace the valve guide (if it is replaceable), oversize it, or knurl it.

Valves

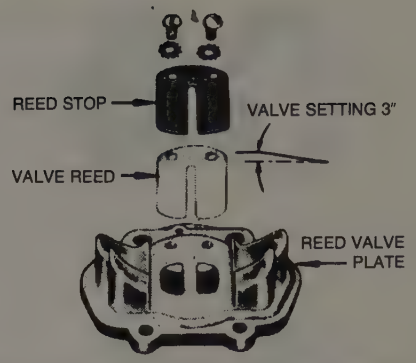
Inspect the valves for a burned face, warped stem or head, scored or damaged stem, worn keeper groove in the stem, and a head margin of less than 1/64 in. If any one of these conditions exists, the valve should be replaced. Check the valve stem diameter. On engines with less than 5 horsepower, the stem diameter should be 0.2475–0.2465 in. On engines over 5 horsepower, the stem diameter is to be 0.310–0.309 in. Any time the valve stem-to-guide clearance can be reduced more than 0.001 in. by replacing the valve with a new one, you should do so. Also any time the stem-to-guide clearance is over 0.0045 in. you should consider doing some rework (new valve guides, seats and valves) to bring the clearance below 0.0045 in. but not less than 0.002 in. If it is determined that the old valve can be reused, then it should be refaced, using an automotive type valve grinder to secure a 45° face angle on the valve with a 1/64 in. margin between the head and the face of the valve.

2-Stroke Engine Reed Valves

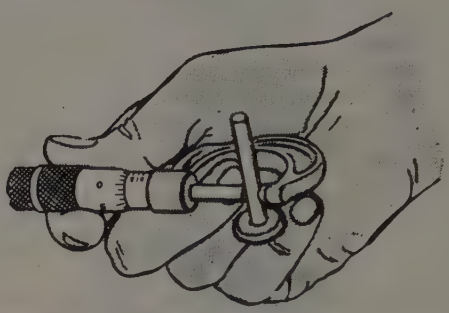
Inspect the reed valves for the following items: broken reed valves, bent or distorted reed valves, damaged or distorted reed valve seat, or a broken or bent reed valve stop. If any of these conditions exist, the reed valve assembly must be replaced.

Valve Springs

To check the condition of valve springs, simply remove the spring from the engine and stand it on a flat surface next to a new valve spring. If the old spring is shorter and leans to one side, it should be replaced with a new spring. Some of the cast iron engines have a stronger or stiffer valve spring installed on the exhaust valve. Make sure that a stiffer spring is installed on the exhaust valve or, to be sure, install two stiff springs in the engine. When a valve seat is rebuilt, the valve then seats further down into the block and this results in a loss of spring tension. To restore spring tension, install a thin washer on top of the valve spring.



Reed valve assembly for two stroke engines



Measuring the tappet stem diameter

Valve Tappets

The valve tappets should be inspected for wear on the head of the tappet and score marks or burrs anywhere else. The tappet should be replaced if any defects are found. Measure the dimensions of the tappet, checking for stem diameter and length. Oversize tappets are not available; however, the tappet guide can be knurled and rebored to correct size should the tappet-to-guide clearance become too large.

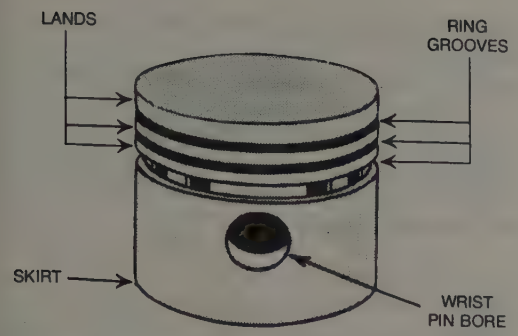
Piston Assembly

Inspect the piston assembly for scored walls, damaged ring lands, worn or damaged wrist pin lock ring grooves, and a cracked or broken piston skirt. If any of these defects are present, the piston must be replaced. Check the dimensions of the piston with a micrometer.

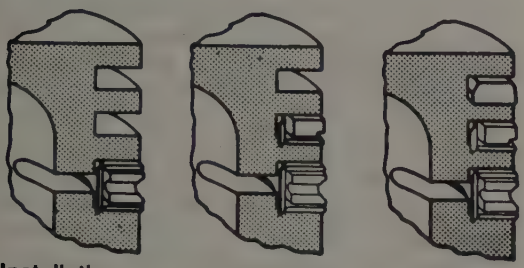
NOTE: *The ring land diameter on 4-stroke engines is tapered and the reading at the ring land will be 0.00125 in. smaller per 1 in. of piston length.*

Clean all carbon deposits from the ring grooves. An old broken ring will serve as an excellent tool for cleaning ring grooves.

Check the side clearances of the rings with new rings installed. The minimum and maximum clearances for oil, scraper, and compression rings are as follows: two stroke engines—0.0015–0.004 in.; four stroke engines under



Names of the piston parts



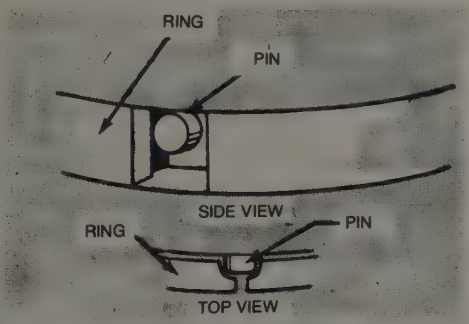
Installation sequence and position for the piston rings

five horsepower—0.002–0.005 in.; four-stroke engines over five horsepower—0.0025–0.005 in.

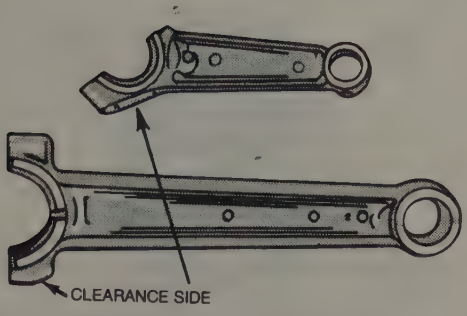
If an oversized piston is used, the amount of the oversize is stamped on the top of the piston.

The ring gap on all engines *except* the 1⅞ in. bore two stroke engine is 0.007–0.017 in. The ring gap on the 1⅞ in. bore two stroke engine is 0.005–0.013 in. Oversize rings are available. Install the rings in the following order: oil ring, scraper ring, and compression ring. The oil ring can be installed with either side up, the scraper ring should have the step on the lower side toward the bottom of the engine's crankcase and the compression ring has to be installed with the bevel on the inside circumference facing upward.

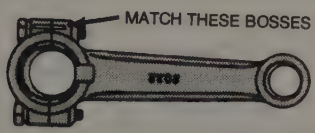
NOTE: *Two stroke engines have wire retainers or pins located in the ring grooves to keep the ring from moving in the groove.*

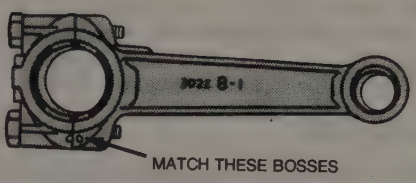


Piston ring retainers in two stroke engines



Install clearance rods with the side marked clearance side facing toward the camshaft





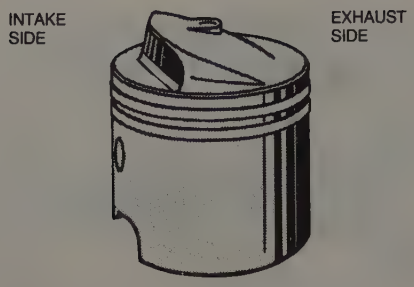
Install the connecting rod cap with the match marks opposite each other

Make sure the ring gap is properly located over these retainers.

Inspect the connecting rod for wear or damage, such as a scored bearing surface, cracks, and damaged threads. Use a micrometer to check all of the connecting rod dimensions. Check the clearance between the wrist pin and the connecting rod at the wrist pin hole. The tolerance for all Clinton engines is 0.0004–0.0011 in. When the clearance reaches 0.002 in., the parts should be replaced with new ones or rebuilt. Clinton, however, does not supply oversize wrist pins.

When installing the piston and connecting rod in a four stroke engine, the piston may go either way, but the rod has an oil hole that must face toward the flywheel side of the engine (with the exception of those engines that use a clearance rod in which the marked side faces toward the camshaft of the engine).

On two stroke engines, the piston is installed with the downward slope of the piston dome facing the exhaust side of the engine. There is no special way for the connecting rod to be installed.



Installation of a two stroke engine piston

Wrist Pins

All Clinton wrist pins are a "hand press fit" into the piston. Care should be taken when removing or installing the wrist pin into rod or piston. It is easy to distort or damage the piston or rod. Never lay a piston on a solid object when removing or installing wrist pin. The piston can be supported in the palm of your hand when servicing to keep from damaging it. There is no special way to install the wrist pin into the piston or rod, except on the 2—cycle engines which in some cases have a hollow wrist pin closed on one end. Make sure the closed end is towards exhaust side.

Crankshaft

Before removing the crankshaft, remove the spark plug and rotate the crankshaft with the starter mechanism, while checking for any wobble of the end of the crankshaft. Any wobbling indicates that the crankshaft is bent and must be replaced. Deviance of 0.001 in. or more is not tolerable. End-play of the crankshaft should be between 0.008 in. and 0.018 in. If the endplay exceeds 0.025 in., the condition should be corrected. End-play is adjusted when the engine is assembled by the addition of various size gaskets behind the bearing plate. It is not recommended that the crankshaft be straightened. Check all bearing surfaces for wear with a micrometer. Replace the crankshaft if it is bent or cracked; if the keyway is damaged; if the taper is damaged; if the flywheel end threads are stripped; or if the bearings are scored.

Bearing Plates and Bases

Inspect these visually, to determine whether or not they can be re-used. Reject for the reasons listed:

A. Broken or cracked, housing mounting flange on the bearing plate or mounting ears or flange base.

B. Cracked or distorted bearing bases.

C. Warped or distorted gasket or mounting surface.

D. Oil seal or bearing pocket oversize.

E. Stripped threads on the lamination hold-down screw holes in the bearing plates or drain and filler plug holes in the bases.

F. Worn crankshaft thrust face surfaces on base or bearing plate.

Camshaft

Check the camshaft for extremely worn lobes and broken gear teeth. Oil pump drive camshafts have a pin located below the gear that must have a squared end and must be secure to the crankshaft. Camshafts from engines with vertical crankshafts have a scoop riveted to the bottom of the gear. Make sure that the scoop is secure. Make sure that on those models equipped with centrifugal advance (ignition) that the advance mechanism is free and the springs are not distorted or broken. Check the dimensions of the camshaft axle.

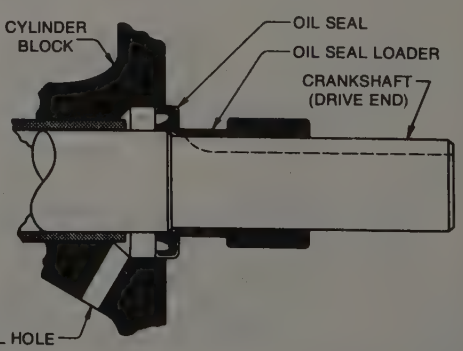
Cylinder

Check the cylinder head for warpage with a straightedge, after removing all dirt and deposits. If the head is warped, place a piece of emery cloth, with the rough side facing up, on a flat surface. Move the cylinder head gasket surface over the emery cloth in a figure eight pattern until the surface of the head is flat. If there are any broken cooling fins or if the spark plug hole threads are stripped, the head must be replaced.

Oil Seals

Oil seals serve two purposes, these being to keep the oil from leaking out of the crankcase on 4-cycle engines, and sealing the crankcase on 2-cycle engines, to keep the vacuum and pressure from being affected by the outside atmospheric pressures.

Any time an engine is being disassembled



Cross section showing use of an oil seal loader

and the oil seals are not going to be replaced with new ones, it is a must that oil seal loaders be installed over the crankshaft or cam gear axle to keep from damaging the seal lips when the base, bearing plate, crankshaft or cam gear is removed. Clinton has oil seal loaders that will fit any diameter shaft used in the Clinton line of engines or you may use an equivalent part designed specifically for this purpose.

Whenever an engine is disassembled or the oil seal removed from it, the oil seal should be given a visual inspection for the following, to determine if it can be reused:

A. Cut or damaged seal lips.

B. Distorted or bent seal.

C. Condition of seal lip to make sure it still is flexible, and has not taken a permanent set.

Any of the above defects, would require replacement of the seal with a new one. To insure that an oil seal will function properly it is recommended that any time an oil seal area of an engine has been worked on new seals be used.

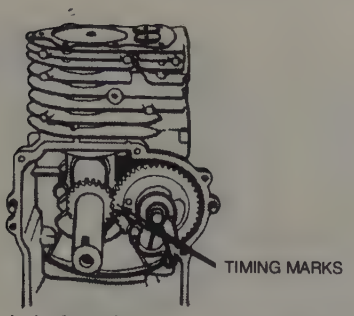
Oil seals should be removed prior to removal and replacement of bearings and reaming of bearings. The oil seals may be removed by prying out or by any means at hand with some care being used not to damage the bearing plate, block, or base to which a new seal must be replaced.

Engine Assembly

FOUR STROKE ENGINES

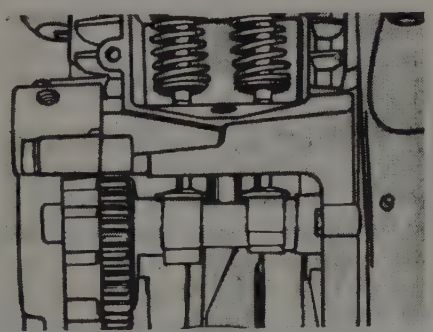
This is a general procedure and is intended to be only a guide since deviations may be necessary for some models.

1. Insert the tappets into the block.
2. Assemble the oil pump to the cam gear, if so equipped.
3. Install the mechanical governor shaft, if so equipped.
4. Install the crankshaft and cam gear into the engine, making sure that the crankshaft thrust washer is in place if one is used.
5. Align the crankshaft and camshaft timing marks.
6. Install the piston and rod assembly using a ring compressor and great caution not to break rings or damage the piston.
7. Install the rod cap and oil dipper, if so equipped, and the cap screw and lock. Tighten to the correct torque. Crimp the screw locks securely.
8. Install the bearing plate and base plate or end cover assembly to the cylinder block. Check the crankshaft end-play. Engines using sleeve bearings should have 0.005–0.002 in. end-play. Engines using tapered roller bearings should have 0.001–0.006 in. end-play. Engines using roller bearings have no end-play specifications; however, care should be taken not to have the crankshaft too tight after assembly. The end-play is adjusted by the installation of various size gaskets between the plate and block.

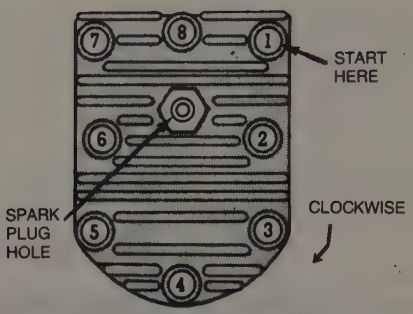


Align the crankshaft and camshaft timing marks

9. Install the oil seals in the PTO and flywheel side of the crankshaft.
10. Install the valves into the block and check the valve stem-to-tappet clearance. Clearance is checked with the lobe of the tappet facing away from the valve. Clearance for a four stroke engine is 0.009–0.012 in. Clearance is adjusted by grinding or filing the valve stem.
11. Using a valve spring compressor, assemble the valve springs to the valves.
12. Install the breather assembly into the valve spring chamber and install the cover.
13. Install the cylinder deflector into the engine.
14. Assemble the magneto assembly to the engine block or bearing plate, whichever is applicable, making sure that the points are clean and adjusted to the correct gap.
15. Install the flywheel, flywheel screen, and starter cup to the crankshaft. Tighten the flywheel nut to the proper specification.
16. Install the carburetor assembly and governor, making sure that the governor assembly links and springs are placed in their original holes.



Adjust the valve-to-tappet clearance with the tappets completely off of the cam lobes



Cylinder head bolt tightening sequence

17. Place the cylinder head on the block. Torque the head bolts in three stages, in the proper sequence, and to the proper torque.
18. Install the blower housing to the engine.
19. Install the spark plug, muffler assembly, and air cleaner.

TWO-STROKE ENGINES

1. Assemble the piston and rod assembly and install it into the block with the help of a piston ring compressor. Be careful not to damage the rings or the piston.
2. Install the crankshaft into the block, installing the crankshaft thrust washer if the engine is so equipped.
3. Assemble the connecting rod and piston assembly to the crankshaft by installing the connecting rod cap and cap screws. Tighten the cap screws to the correct torque.
4. Install the reed valve plate to the engine.
5. Install the bearing plate. Engines that use sleeve bearings should have a crankshaft end-play measuring 0.005–0.020 in. Engines using ball bearings have no specific end-play measurement but make sure that the crankshaft is not tight after assembly. End-play can be adjusted by the addition of various size gaskets behind the bearing plate.
6. Install the bearing oil seals on the PTO side and the flywheel side of the crankshaft.
7. Install the magneto to the bearing plate and adjust the points to the proper gap.
8. Install the flywheel, flywheel screen, and the starter cup to the crankshaft. Tighten the flywheel attaching nut to the correct torque specification.
9. Assemble the carburetor, governor links, springs, and air vane to the engine. Always replace all governor components in the same position from which they were removed.
10. Install the cylinder deflector to the engine.
11. Install the gas tank.
12. Install the air cleaner, spark plug, and muffler.

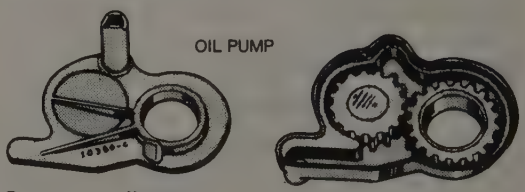
LUBRICATION SYSTEM

All four stroke engines with vertical crankshafts are lubricated by either a camshaft driven gear type oil pump or an oil scoop attached to the camshaft which rotates in the oil lying in the bottom of the crankcase. The gear type pump forces oil up through a steel tube to the upper main bearing. The oil then falls down onto other parts needing to be lubricated.

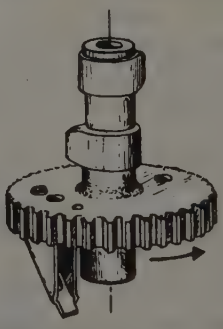
The oil scoop attached to the camshaft sprays oil to the top of the engine in a circular path. The upper main bearing in oil scoop engines has an oil access slot in the top of the bearing area to catch the oil as it is splashed up.

On four-stroke engines that have a horizontal crankshaft, there is an oil dipper or distributor located on the bottom of the connecting rod bearing cap. As the crankshaft turns, the dipper churns through the oil in the crankcase and splashes it to all moving parts that need lubrication. There are oil passages, holes, and slots which the oil passes through on its way to the bearing surfaces.

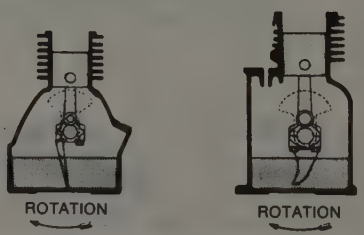
All connecting rods have oil access holes or chambers to insure adequate lubrication. Make sure that all oil access holes are installed facing toward the top main bearing in engines with vertical crankshafts.



Gear type oil pump



Camshaft mounted oil scoop



Connecting rod cap mounted oil dipper

General Engine Specifications

		1	2	3	4	5	6	7	8	9
Cylinder Bore Dia.	Min.	2.3745	2.3745	2.3745	2.3745	2.000	2.000	2.000	2.125	2.375
	Max.	2.3755	2.3755	2.3755	2.3755	2.001	2.001	2.001	2.126	2.376
Piston Skirt Dia.	Min.	2.3690	2.3690	2.3690	2.3690	1.9935	1.9935	1.9935	2.119	2.3690
	Max.	2.3700	2.3700	2.3700	2.3700	1.9945	1.9945	1.9945	2.120	2.3700
Piston Skirt to Cylinder Clearance	Min.	.0045	.0045	.0045	.0045	.0045	.0045	.0045	.005	.0055
	Max.	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.007	.0075
Piston Ring to Groove Clearance	Min.	.002	.002	.002	.002	.002	.002	.002	.002	.002
	Max.	.005	.005	.005	.005	.005	.005	.005	.005	.005
Ring End Gap in Cylinder	Min.	.007	.007	.007	.007	.007	.007	.007	.007	.007
	Max.	.017	.017	.017	.017	.017	.017	.017	.017	.017
Connecting Rod Bore Crankshaft End	Min.	.8140	.8770	.8140	.8770	.7515	.7515	.8770	.8770	.8770
	Max.	.8145	.8775	.8145	.8775	.7520	.7520	.8775	.8775	.8775
Connecting Rod to Crankshaft Clearance	Min.	.0015	.0015	.0015	.0015	.0018	.0018	.0018	.0018	.0018
	Max.	.0030	.0030	.0030	.0030	.0035	.0035	.0035	.0035	.0035
Connecting Rod to Wrist Pin Clearance	Min.	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004
	Max.	.0011	.0011	.0011	.0011	.0011	.0011	.0011	.0011	.0011
Crankshaft Rod Pin Diameter	Min.	.8119	.8745	.8119	.8745	.7483	.7483	.8745	.8745	.8754
	Max.	.8125	.8752	.8125	.8752	.7490	.7490	.8752	.8752	.8752
Crankpin Out-of-Round	Max.	.001	.001	.001	.001	.001	.001	.001	.001	.001
Crankshaft Main Diameter P.T.O. End	Min.	.8733	.8733	.8733	Note	.7483	.8745	.8745	.8745	.8745
	Max.	.8740	.8740	.8740	#1	.7490	.8752	.8752	.8752	.8752
Crankshaft Main Diameter Flywheel End	Min.	.8120	.8120	.8120	.8120	.7483	.7483	.8745	.8745	.8745
	Max.	.8127	.8127	.8127	.8127	.7490	.7490	.8752	.8752	.8752
Crankshaft to Main Bearing Clearance	Min.	.0018	.0018	.0018	.0018	.0018	.0018	.0018	.0018	.0018
	Max.	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035
Crankshaft End Play	Min.	.008	.008	.008	.008	.004	.004	.008	.008	.008
	Max.	.018	.018	.018	.018	.012	.012	.018	.018	.018
Block or Bearing Plate Main Bearing Bore P.T.O. End	Min.	.8758	.8758	.8758	Note	.7510	.877	.877	.877	.877
	Max.	.8768	.8768	.8768	#5	.7520	.878	.878	.878	.878
Bearing Plate or Block Bearing Bore (Flywheel) End	Min.	.8145	.8145	.8145	.8145	.7510	.7510	.877	.877	.877
	Max.	.8155	.8155	.8155	.8155	.7520	.7520	.878	.878	.878
Valve or Tappet Guide Bore I.D.	Min.	.2495	.2495	.2495	.2495	.2495	.2495	.2495	.2495	.2495
	Max.	.2510	.2510	.2510	.2510	.2510	.2510	.2510	.2510	.2510
Valve Stem to Guide Clearance	Min.	.0015	.0015	.0015	.0015	.0020	.0020	.0020	.0020	.0020
	Max.	.0045	.0045	.0045	.0045	.0045	.0045	.0045	.0045	.0045
Valve Clearance, Intake & Exhaust	Min.	.009	.009	.009	.009	.007	.007	.009	.009	.009
	Max.	.011	.011	.011	.011	.009	.009	.011	.011	.011
Camshaft to Axle Clearance	Min.	.001	.001	.001	.001	.001	.001	.001	.001	.001
	Max.	.003	.003	.003	.003	.003	.003	.003	.003	.003
Camshaft Axle Clearance P.T.O.	Min.	.001	.001	.001	.001					
	Max.	.003	.003	.003	.003					
Camshaft Axle Clearance Flywheel End	Min.	.001	.001	.001	.001					
	Max.	.003	.003	.003	.003					
Point Setting	Min.	.018	.018	.018	.018	.018	.018	.018	.018	.018
	Max.	.021	.021	.021	.021	.021	.021	.021	.021	.021
Spark Plug Gap	Min.	.025	.025	.025	.025	.025	.025	.025	.025	.025
	Max.	.028	.028	.028	.028	.028	.028	.028	.028	.028
Comp. at Cranking Speed, P.S.I.	Min.	65	65	65	65	65	65	65	65	65
Carburetor Float Setting (Clinton)	Min.	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32
	Max.	11/64	11/64	11/64	11/64	11/64	11/64	11/64	11/64	11/64
Carburetor Float Setting (Carter)	Min.	11/64	11/64	11/64	11/64	11/64	11/64	11/64	11/64	11/64
	Max.	13/64	13/64	13/64	13/64	13/64	13/64	13/64	13/64	13/64
Magneto Air Gap	Min.	.007	.007	.007	.007	.007	.007	.007	.007	.007
	Max.	.017	.017	.017	.017	.017	.017	.017	.017	.017
Magneto Edge Gap (Phelon)	Min.	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32
	Max.	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32
Magneto Edge Gap (Clinton)	Min.	7/64	7/64	7/64	7/64			7/64	7/64	7/64
	Max.	1/4	1/4	1/4	1/4			1/4	1/4	1/4
Oil Recommended A.P.I. Rating	See Bulletin #9 for SAE	MM MS	MM MS	MM MS	MM MS	MM MS	MM MS	MM MS	MM MS	MM MS
Fuel Recommended		Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas

Note 1 Crankshaft diameter .8733 to .8740 or .9995 to 1.0002, except 435-0000-000 which is 1.220 to 1.221.
Note 2 Ball, needle or roller bearing used. Check component parts, if worn or defective, replace.
Note 3 Wrist pin clearance, .0004 minimum, .0011 maximum or umits other than listed below. Needle bearing used in D65-1000 Type (C), J9-1000 Type (B), J6-1100 and J6-1101. Check component parts, if worn or defective, replace.
Note 4 412-0000-000, 413-0000-000 with sleeve bearings .002 to .006, 412-0300-000 with roller bearings .001 to .006.
Note 5 Bearing bore diameter .8758 to .8768 or 1.0002 to 1.0003, except 435-0000-000 which is 1.2228 to 1.2235.
Note 6 Valve guides .312 to .313 inside diameter and are replaceble. Tappet guide inside diameter .437 to .438.
Note 7 412-0000-000 .001 minimum, .004 maximum. 413-0000-000 .0005 minimum, .002 maximum.

General Engine Specifications (cont.)

		10	11	12	13	14	15	16	17	18
Cylinder Bore Dia.	Min.	2.375	2.375	2.4685	2.4685	2.4685	2.499	2.8125	2.8125	2.8125
	Max.	2.376	2.376	2.4695	2.4695	2.4695	2.500	2.8135	2.8135	2.8135
Piston Skirt Dia.	Min.	2.3690	2.3690	2.4630	2.4630	2.4630	2.4935	2.8045	2.8045	2.8045
	Max.	2.3700	2.3700	2.4640	2.4640	2.4640	2.4945	2.8055	2.8055	2.8055
Piston Skirt to Cylinder Clearance	Min.	.0055	.0055	.0055	.0055	.0055	.0045	.007	.007	.007
	Max.	.0075	.0075	.0075	.0075	.0075	.0065	.009	.009	.009
Piston Ring to Groove Clearance	Min.	.002	.002	.002	.002	.002	.002	.0025	.0025	.0025
	Max.	.005	.005	.005	.005	.005	.005	.0050	.0050	.0050
Ring End Gap in Cylinder	Min.	.007	.007	.007	.007	.007	.007	.007	.007	.007
	Max.	.017	.017	.017	.017	.017	.017	.017	.017	.017
Connectng Rod Bore Crankshaft Ends	Min.	.8770	.9140	.8770	.9140	.9140	.8770	1.2510	1.1265	1.1265
	Max.	.8775	.9145	.8775	.9145	.9145	.8775	1.2513	1.1268	1.1268
Connectng Rod to Crankshaft Clearance	Min.	.0018	.0018	.0018	.0018	.0018	.0015	.001	.0015	.0015
	Max.	.0035	.0035	.0035	.0035	.0035	.0035	.002	.0025	.0025
Connectng Rod to Wrist Pin Clearance	Min.	.0004	.0004	.0004	.0004	.0004	.0004	.0002	.0002	.0002
	Max.	.0011	.0011	.0011	.0011	.0011	.0011	.0011	.0011	.0011
Crankshaft Rod Pin Diameter	Min.	.8745	.9114	.8745	.9114	.9114	.8745	1.2493	1.1243	1.1243
	Max.	.8752	.9120	.8752	.9120	.9120	.8752	1.2500	1.1250	1.1250
Crankpin Out-of Round	Max.	.001	.001	.001	.001	.001	.001	.001	.001	.001
Crankshaft Main Diameter P.T.O. End	Min.	.9995	.9995	Note	Note	.9995	1.220	1.2510	Note	Note
	Max.	1.0002	1.0002	#2	#2	1.0002	1.221	1.2515	#2	#2
Crankshaft Main Diameter Flywheel End	Min.	.8745	.8745	Note	Note	.8745	.8120	1.2510	Note	Note
	Max.	.8752	.8752	#2	#2	.8752	.8127	1.2515	#2	#2
Crankshaft to Main Bearing Clearance	Min.	.0018	.0018	Note	Note	.0018	.0018	.0010	Note	Note
	Max.	.0035	.0035	#2	#2	.0035	.0035	.0025	#2	#2
Crankshaft End Play	Min.	.008	.008	.001	.001	.008	.008	Note	.006	.001
	Max.	.018	.018	.006	.006	.018	.018	#4	.020	.006
Block or Bearing Plate Main Bearing Bore P.T.O. End	Min.	1.002	1.002	Note	Note	1.002	1.2228	1.2525	Note	Note
	Max.	1.003	1.003	#2	#2	1.003	1.2235	1.2535	#2	#2
Bearing Plate or Block Bearing Bore (Flywheel) End	Min.	.877	.877	Note	Note	.877	.8145	1.2525	Note	Note
	Max.	.878	.878	#2	#2	.878	.8155	1.2535	#2	#2
Valve or Tappet Guide Bore I.D.	Min.	.2495	.2495	.2495	.2495	.2495	.2495	.312	Note	Note
	Max.	.2510	.2510	.2510	.2510	.2510	.2510	.313	#6	#6
Valve Stem to Guide Clearance	Min.	.0020	.0020	.0020	.0020	.0020	.0015	.002	.002	.002
	Max.	.0045	.0045	.0045	.0045	.0045	.0045	.004	.004	.004
Valve Clearance, Intake & Exhaust	Min.	.009	.009	.009	.009	.009	.009	.011	.010	.010
	Max.	.011	.010	.010	.010	.010	.011	.012	.012	.012
Camshaft to Axle Clearance	Min.	.001	.001	.001	.001	.001			.0015	.0015
	Max.	.003	.003	.003	.003	.003			.0035	.0035
Camshaft Axle Clearance P.T.O.	Min.						.001	Note		
	Max.						.003	#7		
Camshaft Axle Clearance Flywheel End	Min.						.001	.001		
	Max.						.003	.003		
Point Setting	Min.	.018	.018	.018	.018	.018	.018	.018	.028	.028
	Max.	.021	.021	.021	.021	.021	.021	.021	.030	.030
Spark Plug Gap	Min.	.025	.025	.025	.025	.025	.025	.025	.025	.025
	Max.	.028	.028	.028	.028	.028	.028	.028	.028	.028
Comp. at Cranking Speed, P.S.I.	Min.	65	65	65	65	65	65	65	70	70
Carburetor Float Setting (Clinton)	Min.	5/32	5/32	5/32	5/32	5/32	5/32	5/32		11/64
	Max.	11/64	11/64	11/64	11/64	11/64	11/64	11/64		13/64
Carburetor Float Setting (Carter)	Min.	11/64	11/64	11/64	11/64	11/64			15/64	15/64
	Max.	13/64	13/64	13/64	13/64	13/64			17/64	17/64
Magneto Air Gap	Min.	.007	.007	.007	.007	.007	.007	.007	.012	.012
	Max.	.017	.017	.017	.017	.017	.017	.017	.020	.020
Magneto Edge Gap (Phelon)	Min.	5/32	5/32	5/32	5/32	5/32				
	Max.	9/32	9/32	9/32	9/32	9/32				
Magneto Edge Gap (Clinton)	Min.	7/64	7/64	7/64	7/64	7/64	7/64	7/64		
	Max.	1/4	1/4	1/4	1/4	1/4	1/4	1/4		
Oil Recommended A.P.I. Rating	See Bulletin #9 for SAE	MM MS	MM MS	MM MS	MM MS	MM MS	MM MS	MM MS	MM MS	MM MS
Fuel Recommended		Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas

Note 1 Crankshaft diameter .8733 to .8740 or .9995 to 1.0002, except 435-0000-000 which is 1.220 to 1.221.
Note 2 Ball, needle or roller bearing used. Check component parts, if worn or defective, replace.
Note 3 Wrist pin clearance, .0004 minimum, .0011 maximum or umits other than listed below. Needle bearing used in D65-1000 Type (C), J9-1000 Type (B), J6-1100 and J6-1101. Check component parts, if worn or defective, replace.
Note 4 412-0000-000, 413-0000-000 with sleeve bearings .002 to .006, 412-0300-000 with roller bearings .001 to .006.
Note 5 Bearing bore diameter .8758 to .8768 or 1.0002 to 1.0003, except 435-0000-000 which is 1.2228 to 1.2235.
Note 6 Valve guides .312 to .313 inside diameter and are replaceble. Tappet guide inside diameter .437 to .438.
Note 7 412-0000-000 .001 minimum, .004 maximum. 413-0000-000 .0005 minimum, .002 maximum.

General Engine Specification (cont.)

		19	20	21	22	23	24	25	26	27
Cylinder Bore Dia.	Min.	2.9995	3.1245	3.1245	3.1245	3.1245	1.875	1.875	2.125	2.125
	Max.	3.0005	3.1255	3.1255	3.1255	3.1255	1.876	1.876	2.126	2.126
Piston Skirt Dia.	Min.	2.9915	3.117	3.117	3.1185	3.1185	1.8695	1.8695	2.1195	2.1195
	Max.	2.9925	3.118	3.118	3.1195	3.1195	1.8705	1.8705	2.1205	2.1205
Piston Skirt to Cylinder Clearance	Min.	.007	.0065	.0065	.005	.005	.0045	.0045	.005	.005
	Max.	.009	.0085	.0085	.007	.007	.0065	.0065	.007	.007
Piston Ring to Groove Clearance	Min.	.0025	.0025	.0025	.0025	.0025	.0015	.0015	.0015	.0015
	Max.	.0050	.0050	.0050	.0050	.0050	.0040	.0040	.0040	.0040
Ring End Gap in Cylinder	Min.	.007	.010	.010	.010	.010	.005	.005	.007	.007
	Max.	.017	.020	.020	.020	.020	.013	.013	.017	.017
Connecting Rod Bore Crankshaft End	Min.	1.1265	1.2510	1.2510	1.2510	1.2510	.7820	.7820	.7820	.7820
	Max.	1.1268	1.2513	1.2513	1.2513	1.2513	.7827	.7827	.7827	.7827
Connecting Rod to Crankshaft Clearance	Min.	.0015	.0010	.0010	.0010	.0010	.0026	.0026	.0026	.0026
	Max.	.0025	.0018	.0018	.0018	.0018	.0040	.0040	.0040	.0040
Connecting Rod to Wrist Pin Clearance	Min.	.0002	.0002	.0002	.0002	.0002	.0004	.0004	.0004	.0004
	Max.	.0011	.0011	.0011	.0011	.0011	.0011	.0011	.0011	.0011
Crankshaft Rod Pin Diameter	Min.	1.1243	1.2495	1.2495	1.2495	1.2495	.7788	.7788	.7788	.7788
	Max.	1.1250	1.2500	1.2500	1.2500	1.2500	.7795	.7795	.7795	.7795
Crankpin Out-of-Round	Max.	.001	.001	.001	.001	.001	.001	.001	.001	.001
Crankshaft Main Diameter P.T.O. End	Min.	Note	Note	Note	Note	Note	.8745	.8745	.8745	.9995
	Max.	#2	#2	#2	#2	#2	.8752	.8752	.8752	1.0002
Crankshaft Main Diameter Flywheel End	Min.	Note	Note	Note	Note	Note	.7495	.7495	.7495	.7495
	Max.	#2	#2	#2	#2	#2	.7502	.7502	.7502	.7502
Crankshaft to Main Bearing Clearance	Min.	Note	Note	Note	Note	Note	.0015	.0015	.0015	.0015
	Max.	#2	#2	#2	#2	#2	.0035	.0035	.0035	.0035
Crankshaft End Play	Min.	.001	.006	.001	.006	.001	.005	.005	.005	.005
	Max.	.006	.020	.006	.020	.006	.020	.020	.020	.020
Block or Bearing Plate Main Bearing Bore P.T.O. End	Min.	Note	Note	Note	Note	Note	.8770	.8770	.8770	1.002
	Max.	#2	#2	#2	#2	#2	.8780	.8780	.8780	1.003
Bearing Plate or Block Bearing Bore (Flywheel) End	Min.	Note	Note	Note	Note	Note	.7517	.7517	.7517	.7517
	Max.	#2	#2	#2	#2	#2	.7525	.7525	.7525	.7525
Valve or Tappet Guide Bore I.D.	Min.	Note	Note	Note	Note	Note				
	Max.	#6	#6	#6	#6	#6				
Valve Stem to Guide Clearance	Min.	.002	.002	.002	.002	.002				
	Max.	.004	.004	.004	.004	.004				
Valve Clearance, Intake & Exhaust	Min.	.010	.010	.010	.010	.010				
	Max.	.012	.012	.012	.012	.012				
Camshaft to Axle Clearance	Min.	.0015	.0015	.0015	.0015	.0015				
	Max.	.0035	.0035	.0035	.0035	.0035				
Camshaft Axle Clearance P.T.O.	Min.									
	Max.									
Camshaft Axle Clearance Flywheel End	Min.									
	Max.									
Point Setting	Min.	.028	.028	.028	.028	.028	.018	.018	.018	.018
	Max.	.030	.030	.030	.030	.030	.021	.021	.021	.021
Spark Plug Gap	Min.	.025	.025	.025	.025	.025	.025	.025	.025	.025
	Max.	.028	.028	.028	.028	.028	.028	.028	.028	.028
Comp. at Cranking Speed, P.S.I.	Min.	70	70	70	70	70	60	60	60	60
Carburetor Float Setting (Clinton)	Min.	11/64		11/64		11/64	5/32	5/32	5/32	5/32
	Max.	13/64		13/64		13/64	11/64	11/64	11/64	11/64
Carburetor Float Setting (Carter)	Min.	15/64	15/64	15/64	15/64	15/64	11/64	11/64	11/64	11/64
	Max.	17/64	17/64	17/64	17/64	17/64	13/64	13/64	13/64	13/64
Magneto Air Gap	Min.	.012	.012	.012	.012	.012	.007	.007	.007	.007
	Max.	.020	.020	.020	.020	.020	.017	.017	.017	.017
Magneto Edge Gap (Phelon)	Min.						5/32	5/32	5/32	5/32
	Max.						9/32	9/32	9/32	9/32
Magneto Edge Gap (Clinton)	Min.						7/64	7/64	7/64	7/64
	Max.						1/4	1/4	1/4	1/4
Oil Recommended A.P.I. Rating	See Bulletin #9 for SAE	MM MS	MM MS	MM MS	MM MS	MM MS	Outboard Motor Oil or SAE 30 Non Detergent			
Fuel Recommended		Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas

Note 1 Crankshaft diameter .8733 to .8740 or .9995 to 1.0002, except 435-0000-000 which is 1.220 to 1.221.
Note 2 Ball, needle or roller bearing used. Check component parts, if worn or defective, replace.
Note 3 Wrist pin clearance, .0004 minimum, .0011 maximum or umits other than listed below. Needle bearing used in D65-1000 Type (C), J9-1000 Type (B), J6-1100 and J6-1101. Check component parts, if worn or defective, replace.
Note 4 412-0000-000, 413-0000-000 with sleeve bearings .002 to .006, 412-0300-000 with roller bearings .001 to .006.
Note 5 Bearing bore diameter .8758 to .8768 or 1.0002 to 1.0003, except 435-0000-000 which is 1.2228 to 1.2235.
Note 6 Valve guides .312 to .313 inside diameter and are replaceble. Tappet guide inside diameter .437 to .438.
Note 7 412-0000-000 .001 minimum, .004 maximum. 413-0000-000 .0005 minimum, .002 maximum.

General Engine Specifications (cont.)

		28	29	30	31	32	33	34	35	36
Cylinder Bore Dia.	Min.	2.125	2.125	1.8750	2.1255	1.8750	1.811	1.8750	2.1255	2.1255
	Max.	2.126	2.126	1.8765	2.1270	1.8765	1.814	1.8765	2.1270	2.1270
Piston Skirt Dia.	Min.	2.1195	2.1195	1.8695	2.120	1.871	1.807	1.871	2.120	2.120
	Max.	2.1205	2.1205	1.8705	2.121	1.872	1.809	1.872	2.121	2.121
Piston Skirt to Cylinder Clearance	Min.	.005	.005	.0045	.0045	.0045	.003	.0045	.0045	.0045
	Max.	.007	.007	.0065	.0070	.0065	.007	.0065	.0070	.0070
Piston Ring to Groove Clearance	Min.	.0015	.002	.002	.002	.002	.002	.002	.002	.002
	Max.	.0040	.004	.004	.004	.004	.005	.004	.004	.004
Ring End Gap in Cylinder	Min.	.007	.010	.010	.010	.010	.004	.010	.010	.010
	Max.	.017	.015	.015	.015	.015	.020	.015	.015	.015
Connecting Rod Bore Crankshaft End	Min.	.7820	Note	.7816	Note	Note	Note	Note	Note	Note
	Max.	.7827	#2	.7825	#2	#2	#2	#2	#2	#2
Connecting Rod to Crankshaft Clearance	Min.	.0026	Note	.0021	Note	Note	Note	Note	Note	Note
	Max.	.0040	#2	.0037	#2	#2	#2	#2	#2	#2
Connecting Rod to Wrist Pin Clearance	Min.	.0004	.0004	.0004	Note	.0004	Note	.0004	Note	Note
	Max.	.0011	.0011	.0011	#3	.0011	#2	.0011	#3	#3
Crankshaft Rod Pin Diameter	Min.	.7788	.6594	.7788	.6594	.6594	.4960	.6594	.6594	.6594
	Max.	.7795	.6599	.7795	.6599	.6599	.4965	.6599	.6599	.6599
Crankpin Out-of-Round	Max.	.001	.001	.001	.001	.001	.001	.001	.001	.001
Crankshaft Main Diameter P.T.O. End	Min.	.8745	Note	Note	Note	Note	Note	Note	Note	Note
	Max.	.8752	#2	#2	#2	#2	#2	#2	#2	#2
Crankshaft Main Diameter Flywheel End	Min.	.7495	.7495	.7495	.7495	.7495	Note	.7495	.7495	.7495
	Max.	.7502	.7502	.7502	.7502	.7502	#2	.7502	.7502	.7502
Crankshaft to Main Bearing Clearance	Min.	.0015	Note	.0015	Note	Note	Note	Note	Note	Note
	Max.	.0035	#2	.0035	#2	#2	#2	#2	#2	#2
Crankshaft End Play	Min.	.005	Note	Note	Note	Note	.003	.003	.003	Note
	Max.	.020	#2	#2	#2	#2	.020	.020	.020	#2
Block or Bearing Plate Main Bearing Bore P.T.O. End	Min.	.8770	Note	Note	Note	Note	Note	Note	Note	Note
	Max.	.8778	#2	#2	#2	#2	#2	#2	#2	#2
Bearing Plate or Block Bearing Bore (Flywheel) End	Min.	.7517	Note	Note	Note	Note	Note	Note	Note	Note
	Max.	.7525	#2	#2	#2	#2	#2	#2	#2	#2
Valve or Tappet Guide Bore I.D.	Min.									
	Max.									
Valve Stem to Guide Clearance	Min.									
	Max.									
Valve Clearance, Intake & Exhaust	Min.									
	Max.									
Camshaft to Axle Clearance	Min.									
	Max.									
Camshaft Axle Clearance P.T.O	Min.									
	Max.									
Camshaft Axle Clearance Flywheel End	Min.									
	Max.									
Point Setting	Min.	.018	.018	.018	.018	.018	.013	.014	.014	.018
	Max.	.021	.021	.021	.021	.021	.017	.016	.016	.021
Spark Plug Gap	Min.	.025	.025	.025	.025	.025	.025	.025	.025	.025
	Max.	.028	.028	.028	.028	.028	.030	.028	.028	.028
Comp. at Cranking Speed, P.S.I.	Min.	60	60	60	60	60	80	60	60	60
Carburetor Float Setting (Clinton)	Min.	5/32	5/32							1 25/64
	Max.	11/64	11/64							1 27/64
Carburetor Float Setting (Carter)	Min.	11/64	11/64							
	Max.	13/64	13/64							
Magneto Air Gap	Min.	.007	.007	.007	.007	.007	.007	.007	.007	.007
	Max.	.017	.017	.017	.017	.017	.017	.017	.017	.017
Magneto Edge Gap (Phelon)	Min.	5/32								
	Max.	9/32								
Magneto Edge Gap (Clinton)	Min.	7/64	7/64	7/64	7/64	7/64	3/32	3/32	3/32	7/64
	Max.	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	1/4
Oil Recommended A.P.I. Rating		Outboard Motor Oil or SAE 30 Non Detergent								
Fuel Recommended		Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg. Gas	Reg Gas	Reg. Gas

Note 1 Crankshaft diameter .8733 to .8740 or .9995 to 1.0002, except 435-0000-000 which is 1.220 to 1.221.
Note 2 Ball, needle or roller bearing used. Check component parts, if worn or defective, replace.
Note 3 Wrist pin clearance, .0004 minimum, .0011 maximum or umits other than listed below. Needle bearing used in D65-1000 Type (C), J9-1000 Type (B), J6-1100 and J6-1101. Check component parts, if worn or defective, replace.
Note 4 412-0000-000, 413-0000-000 with sleeve bearings .002 to .006, 412-0300-000 with roller bearings .001 to .006.
Note 5 Bearing bore diameter .8758 to .8768 or 1.0002 to 1.0003, except 435-0000-000 which is 1.2228 to 1.2235.
Note 6 Valve guides .312 to .313 inside diameter and are replaceble. Tappet guide inside diameter .437 to .438.
Note 7 412-0000-000 .001 minimum, .004 maximum. 413-0000-000 .0005 minimum, .002 maximum.

Torque Specifications

		All 4 Cycle Aluminum Vertical & Horizontal Shaft	V100, V3100, 406, H3100 407, 417	429 & 431	A300	300, VS300, 350, 500, 650, 700A, C700 D700, VS700, VS750, 800, A800, VS800 900, VS900, V1000, A-B-1100, C1100, D1100, V1100, VS1100, 1200, A1200, B1290, V1200, VS1200, 492, 494, 497, 498, 499	412 & 413	1600, 1800, 2500, 2790 414, 416, 418, 420, 422	200, A200, VS200, VS400, A400, 500, 501	E65 & GK590	E10—Chainsaw	D15—Chainsaw D25—Chainsaw	D35, D55, D65—Chainsaws E75, E95,—Chainsaws	J5, J6, J7, J8, J9—Outboards
Connecting Rod Aluminum	Min.	100	100	100	70	70	215	215	35	70	50	55	80	80
	Max.	125	125	125	80	80	235	235	45	80	55	65	90	90
Connecting Rod Forged Steel	Min.									90			90	90
	Max.									100			100	100
Bearing Plate P.T.O. End	Min.	75	75	75			75	160						
	Max.	85	85	85			85	180						
Bearing Plate Flying End	Min.				120	140			75	75		80	80	75
	Max.				150	160			95	95		90	90	95
Back Plate to Block	Min.							70						
	Max.							80						
Head Bolts	Min.	125	225	225	200	200	200	200						
	Max.	150	250	250	220	220	220	220						
Base Bolts	Min.	75	75	75	150	325	75	150	125	125				
	Max.	85	85	85	160	375	85	160	150	150				
End Cover or Gear Box	Min.					120								
	Max.					150								
Speed Reducer Mounting	Min.	110	110		110	110	110	110	110					
	Max.	150	150		150	150	150	150	150					
P.T.O. Housing or Mounting Flange	Min.	75	75	75		120	75	160	125					
	Max.	85	85	85		150	85	180	150					
Carb. Reed Plate or Manifold to Blk.	Min.	60	60	60	60	60	65	60	60	60	45	50	50	50
	Max.	65	65	65	65	65	75	65	65	65	55	60	60	60
Carb. to Reed Plate or Manifold	Min.	35	35	35	60	35	35	60	60	60		50	50	50
	Max.	50	50	50	65	50	50	65	65	65		60	60	60
Blower Housing	Min.	60	60	60	65	65	65	65	65	65	90	80	80	75
	Max.	70	70	70	70	70	75	70	70	70	110	90	90	85
Muffler to Block	Min.	110	110	110	140	140	170	170	40	40	90	60	60	
	Max.	120	120	120	150	150	180	180	60	60	110	70	70	
Flywheel	Min.	375	375	375	375	400	400	*100	375	250	150	375	**250	250
	Max.	400	400	400	400	450	500	*120	400	300	180	425	**300	300
Flywheel Touch & Stop for Brake	Min.	650	650											
	Max.	700	700											
Spark Plug	Min.	275	275	275	275	275	275	275	275	275	250	230	230	230
	Max.	300	300	300	300	300	300	300	300	300	300	270	270	270
Stator Plate	Min.	50	50	50	50	50	50	80	50	50	50	50	50	45
	Max.	60	60	60	60	60	60	100	60	60	60	60	60	65

All torque in inch pounds except those marked with a single*
*Foot Pounds
**D35 Requires Same as D25

Cross Reference Chart

Model No.	Column No.
E–65	29
100	1
100–1000	1
100–2000	1
V100–1000	3
VS100	3
VS100–1000	3
VS100–2000	3
VS100–3000	3
VS100–4000	3
200	24
A200	24
AVS200	24
AVS200–1000	25
VS200	24
VS200–1000	24
VS200–2000	25
VS200–3000	25
VS200–4000	27
300	5
A300	5
VS300	6
350	5
A400	28
A400–1000	28
AVS400	26
AVS400–1000	27
BVS400	27
CVS400–1000	27
VS400	26
VS400–1000	26
VS400–2000	27
VS400–3000	27
VS400–4000	27
GK590	29
650	7
700–A	7
B700	7
C700	7
D700	8
D700–1000	8
D700–2000	8
D700–3000	8
VS700	7
VS750	7
800	9
A800	9
VS800	9
900	9
900–1000	9
900–2000	9
900–3000	9
900–4000	9
VS900	10
V1000–1000	10
VS1000	10
A&B1100	9
C1100	9
D1100	9
V1100–1000	11
VS1100	11
VS1100–1000	11
1200	12
1200–1000	12
1200–2000	13
A1200	13
B1290–1000	13
V1200–1000	14
VS1200	14
1600	17
A1600–1000	18
1800–1000	19
2100	1
A2100	1
A2100–1000	1
A2100–2000	1
VS2100	3
VS2100–1000	3
VS2100–2000	3
VS2100–3000	3
2500	20
A2500	22
B2500–1000	21
2790–1000	23
VS3000	3
3100	2
3100–1000	2
3100–2000	2
3100–3000	2
H3100–1000	2
FV3100–1000	4
AFV3100–1000	4
AV3100–1000	4
AV3100–2000	4
AVS3100	4
AVS3100–1000	4
AVS3100–2000	4
AVS3100–3000	4
V3100–1000	4
V3100–2000	4
VS3100	4
VS3100–1000	4
VS3100–2000	4
VS3100–3000	4
4100	2
4100–1000	2
4100–2000	2
AVS4100–1000	4
AVS4100–2000	4
VS4100–1000	4
VS4100–2000	4
J–5	36
J–6	36
J–7	36
J–8	36

Cross Reference Chart (cont.)

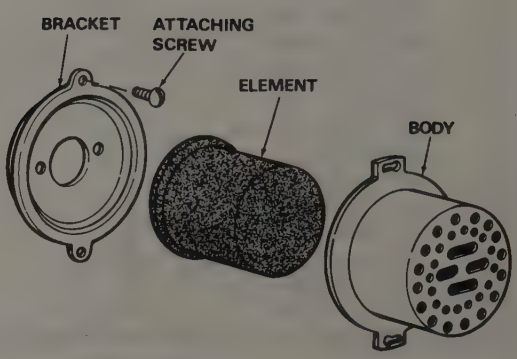
Model No.	Column No.
J-9	36
E10-1000	33
D15-1000	30
D25-1000	30
D35-1000	31
D55-1000	32
D65-1000	31
E75-1000	34
E95-1000	35
400-0000-000	1
401-0000-000	3
402-0000-000	1
403-0000-000	3
404-0000-000	2
405-0000-000	4
406-0000-000	2
407-0000-000	4
407-0002-000	4
408-0000-000	2
409-0000-000	4
411-0000-000	3
411-0002-000	3
412-0000-000	16
413-0000-000	16
414-1300-000	18
414-1301-000	18
415-0000-000	4
415-0002-000	4
416-1300-000	18
417-0000-000	4
418-1300-000	19
418-1301-000	19
420-1300-000	21
420-1301-000	21
422-1300-000	23
422-1301-000	23
424-0000-000	2
426-0000-000	2
429-0003-000	15
431-0003-000	15
435-0003-000	4
492-0300-000	9
494-0000-000	9
494-0001-000	9
497-0000-000	14
498-0300-000	13
498-0301-000	13
499-0000-000	14
500-0000-000	28
501-0000-000	27
501-0001-000	27

6

Jacobsen

ENGINE IDENTIFICATION

The Jacobsen 321 and 501 engines are almost identical, with only minor differences. These engines are 2-cycle design and can be used in both horizontal and vertical applications. Both engines are single cylinder models. The 501 is a heavy duty version of the 321. A stamped plate showing the engine type is affixed to the crankcase.



Typical air cleaner

MAINTENANCE

Air Cleaners

Four types of air cleaners are used on these engines. The type of air cleaner depends on the engine application. An aluminum foil, paper, oil bath and polyurethane filter can be found on the engine. Proper cleaning and prescribed replacement are necessary to maintain good engine performance.

CLEANING AND REPLACEMENT

Aluminum Foil Type

Periodically wash the filter in a safe solvent. Shake off the excess solvent and air-dry the filter. Dip the filter in 30W engine oil. Allow the excess oil to drain off, and install the filter.

Paper Filter

If the filter is only lightly soiled, tap it gently to remove any loose dirt, then blow compressed air through it from the inside out. If the filter is dirty, replace it.

Oil Bath Type

Remove the cover from the reservoir and dump out the old oil. Wash the air cleaner with a safe solvent. Dry it thoroughly. Refill the air cleaner to the indicated level with the same grade and weight oil used in the engine.

Polyurethane Type

The foam type cleaner should be removed and washed in kerosene. Ring out all the excess kerosene and add about 2 tablespoons of clean 30W engine oil directly into the foam. Squeeze the foam gently to evenly distribute the oil.

Oil and Fuel Recommendations

The proper mixture of gasoline and oil is critical to the performance of a 2-cycle engine. Jacobsen recommends the use of regular, leaded gasoline, mixed with 30W, non-detergent oil meeting specification MM or SB (stamped on top of the can). For the 501, the

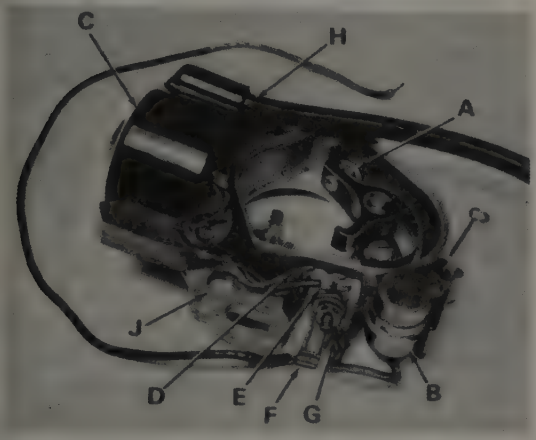
General Engine Specifications

Model	Displacement Cu. In. (cc.)	Hp.	Bore (in.)	Stroke (in.)	Compression Ratio	Compression (psi)
321 & 501	6.2 (101)	3.0	2.125	1.75	5.0:1	75–85

ratio is ½ pint of oil to 1 gallon of gasoline; for the 321, the ratio is ¼ pint of oil to 1 gallon of gasoline. Always mix the oil and fuel in a safe container intended for that purpose. Never mix the oil and fuel in the engine's fuel tank.

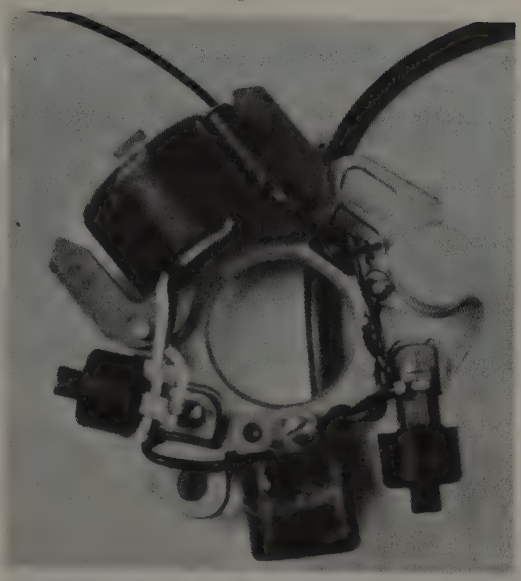
TUNE-UP

These engines use three different types of magnetos: the standard breaker type, the capacitative discharge breakerless (CD) type, and the solid state breakerless type called the Blaser. The Blaser unit is not serviceable, nor is any of its components, therefore it is not covered in this section. If any part fails, the entire solid state system must be replaced as a unit. To determine which system you have, check the accompanying illustrations.



A. Breaker points
B. Condenser
C. Coil (primary and secondary)
D. Coil secondary wire (ground)
E. Coil primary wire (live)
F. Ignition short-out wire (live)
G. Condenser lead (live)
H. High tension lead
J. Stator assembly (includes points, coil condenser)

Breaker type magneto



Breakerless CD magneto

Blaser solid state breakerless magneto

NOTE: *To convert a Blaser magneto to a point-type system, the flywheel must be replaced.*

Stator Assembly

REMOVAL

1. Remove the flywheel.
2. Remove the metal cover and dust shield from the stator.

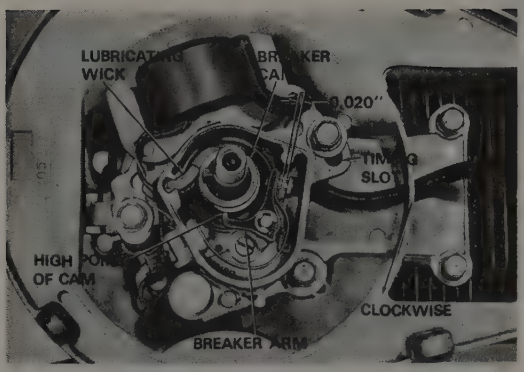
NOTE: *Before removing the stator, check the position of the spark plug wire and the ignition short-out wire. Take note of their position for replacement. If there is a film of fuel around the crankcase seal, it means that the seal must be replaced.*

3. Using a ⅜ inch socket, remove the 2 screws, lockwashers and flat washers from the stator.
4. Disconnect the wire from the spark plug and the coil.
5. Lift out the stator, while guiding the plug wire through the backplate.

INSPECTION

NOTE: *Points should be filed only as an emergency procedure. Filing removes a protective coating which prevents corrosion. Bad points should be replaced.*

1. Check for grounding of the silver leaf tension band on the point arm.



Stator assembly

2. Check for pitting corrosion or dirt on the points.
3. Check for an improperly grounded secondary wire.
4. Check for a loose or grounded primary wire.
5. Check to see if the ignition short-out wire is grounded to the stator plate.
6. Check to see if the condenser wire is loose or grounded to the stator plate.
7. Check for weak or non-existing spark caused by coil damage and/or loose or broken primary wires and secondary wires.
8. Check for timing delay or a weak spark caused by insulation missing from the coil lead.
9. Check for magneto shorting caused by pin-hole leaks in the wiring insulation.
10. Check for improper centering of the stator on top of the seal.
11. Check for a warped stator plate caused by improper centering of the stator around the crankshaft seal.

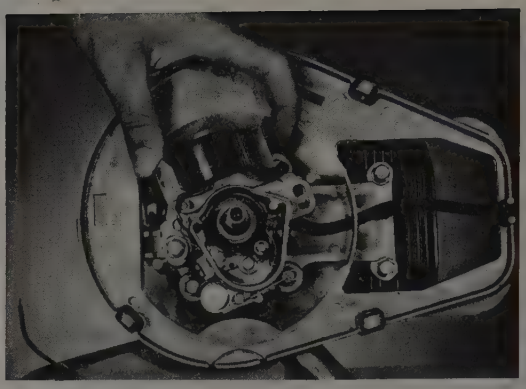
INSTALLATION

1. Carefully position the stator assembly while guiding the spark plug wire through the hole in the backplate.
2. Install the retaining screws and washers.
3. Make sure that the spark plug wire and ignition short-out wire are properly positioned.
4. Insert the high tension lead wire through the hole in the backplate and install the metal spark plug clip to the end of the lead wire.

Ignition Timing

NOTE: *The engine will run with the stator assembly set anywhere within the slotted holes, however, good engine performance can be achieved only with the timing set as follows:*

1. Position the high tension lead wire and the ignition short-out wire under the stator plate.



Setting the timing

NOTE: *The only exception to this timing process is the 20 inch Snow Jet. On this unit the stator must be rotated fully counterclockwise, which will set the ignition timing at full advance 28° or ⅛ inch before top dead center.*

2. From the ignition end of the crankshaft, turn the stator clockwise, as far as it will go. The stator must be seated perfectly flatly around and not on top of the crankshaft seal.
3. Install the two mounting screws. The timing should now be set at 22°, which is $^{1}/_{16}$ inch before top dead center.

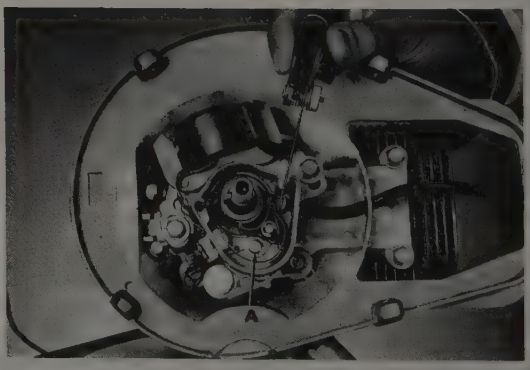
Ignition Points

NOTE: *Be very careful in setting the points. Any slight misalignment will adversely affect performance.*

1. Examine the cam for wear. If wear is obvious, the cam should be replaced. Install the cam so that the shoulder on the cam is facing away from the engine.

NOTE: *Most engines have a shoulder or an arrow on one side of the cam. It is standard practice to install the cam with the arrow or shoulder facing away from the engine.*

2. Install the key that holds the cam and



Adjusting the point gap; A is the adjusting screw

flywheel in place. Rotate the crankshaft clockwise until the point breaker arm is on the highest spot of the cam.

3. Lightly loosen the screw which retains the breaker arm base plate. Insert a .020 feeler gauge between the contact points and use the gauge to separate the points, moving the base plate until the points are properly gapped at .020 in. apart.

4. Tighten the point retaining screw.

NOTE: *Pulling a clean piece of paper through the point opening will wipe off any residue left by your fingers or any oily preservative put on the points to retard corrosion.*

5. Replace the fiber gasket and metal cover.

6. Make sure that there is good spring tension on the cover hold down spring.

Idle Speed and Mixture Adjustments

NEEDLE ADJUSTMENT

1. Check and make sure that the high speed adjusting needle screw is positioned so that the flat side of the screw head is next to the notch in the housing.

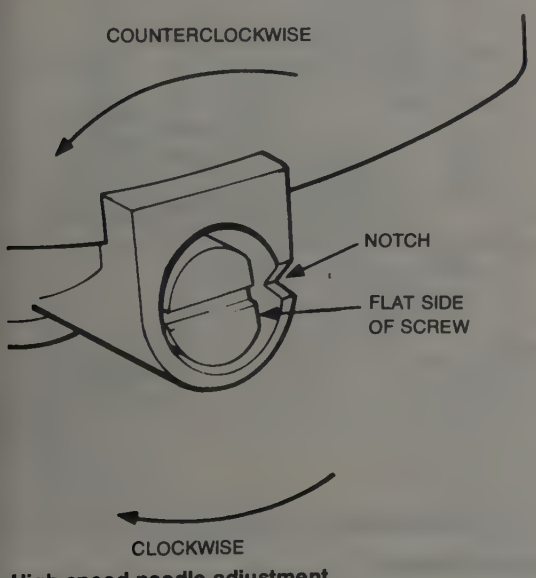
2. Turn the high speed needle screw one full turn counterclockwise.

3. Turn the idle mixture screw one full turn counterclockwise.

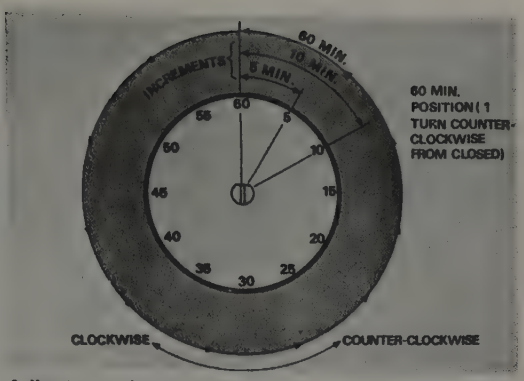
4. Start the engine and set the throttle to full speed and allow the engine to warm up for a few minutes.

5. Turn the high speed needle clockwise ¼ turn. The engine should slow down.

6. Turn the needle back ¼ turn to the 1 turn open position, then turn it counterclockwise ¼ turn. The engine should slow slightly. If not, the carburetor needs repair.



High speed needle adjustment



Adjustment increments

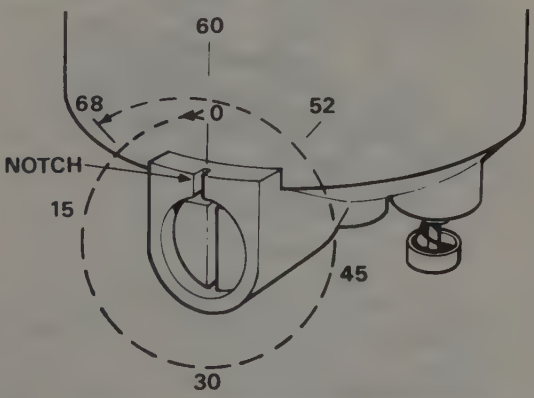
7. Turn the high speed needle back ¼ turn. Then, turn it slowly, clockwise until the engine begins to slow down. This should not take more than ¼ turn. From this point, turn the needle counterclockwise about 1 full turn, or until the engine is running at maximum speed. Then, continue turning the needle counterclockwise, slowly, until the engine gives a slight stuttering sound in the exhaust. No more than 1/16–⅛ turn should be needed.

NOTE: *Final high speed adjustment, or fine-tuning, can be made only after about 20 minutes at full work load. Fine adjustment should give smooth acceleration and just barely give a light exhaust smoke.*

8. Idle adjustment is set after high speed adjustment. Seat the idle adjusting screw gently. Open the screw, counterclockwise, one full turn.

9. Start the engine and move the throttle control to the slow position.

10. Turn the idle screw clockwise in 1/16 turn increments until a satisfactory idle is obtained, then turn it back 1/16 turn.



ALL NUMBERS ILLUSTRATE THE MINUTES OF TRAVEL ON A CLOCK FACE WITH "0" REPRESENTING THE STARTING NOTCH FOR ADJUSTMENT

Final adjustment

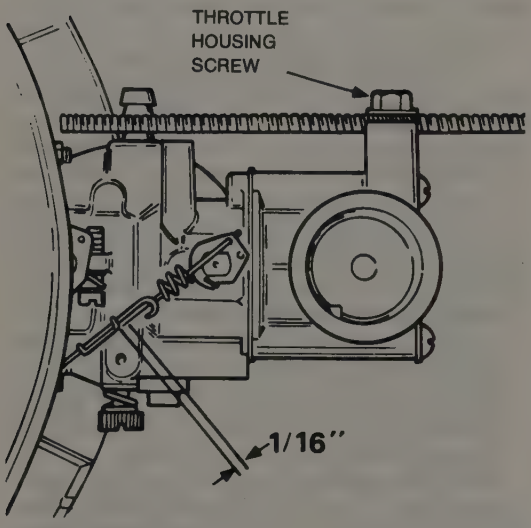
FUEL SYSTEM

Carburetors

CHOKE ADJUSTMENT

This adjustment is possible only on those engines with handle-mounted throttle control levers. Any time that the handle or control wires are removed and/or reassembled the choke must be adjusted.

1. On units with a single, four position control on the handle, set the lever to the FAST position.
2. Check the hook in the control link to be sure that it is in contact with, or no more than 1/16 inch away from the first loop in the choke spring.
3. If the choke is partially on the loop, or if there is more than 1/16 inch clearance between the hook and the loop, loosen the screw holding the throttle wire housing.
4. At this point, the housing may be moved forward or rearward to make the correct setting. After the housing is positioned properly, tighten the throttle housing screw securely.



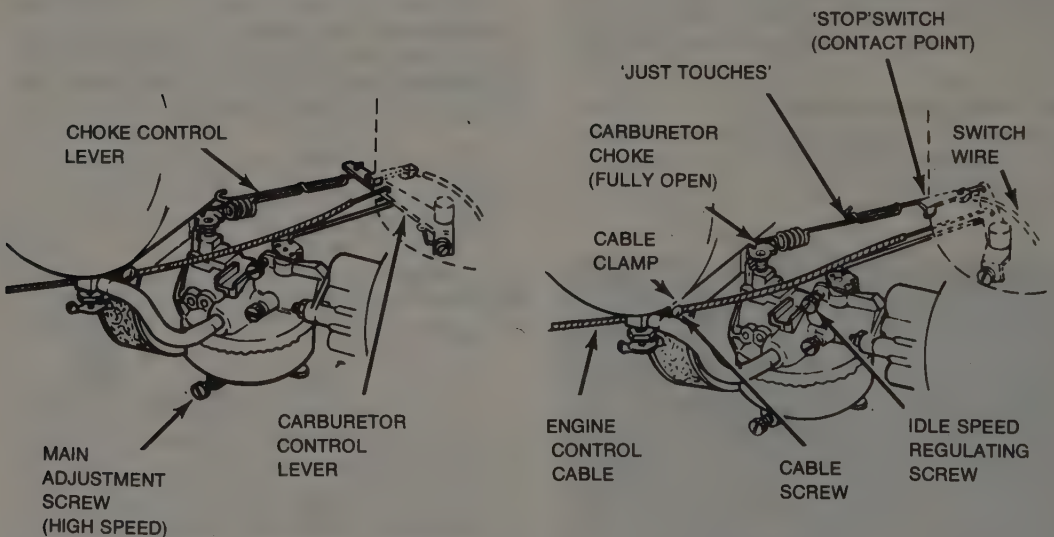
Choke adjustment

ENGINE CONTROL CABLE ADJUSTMENT

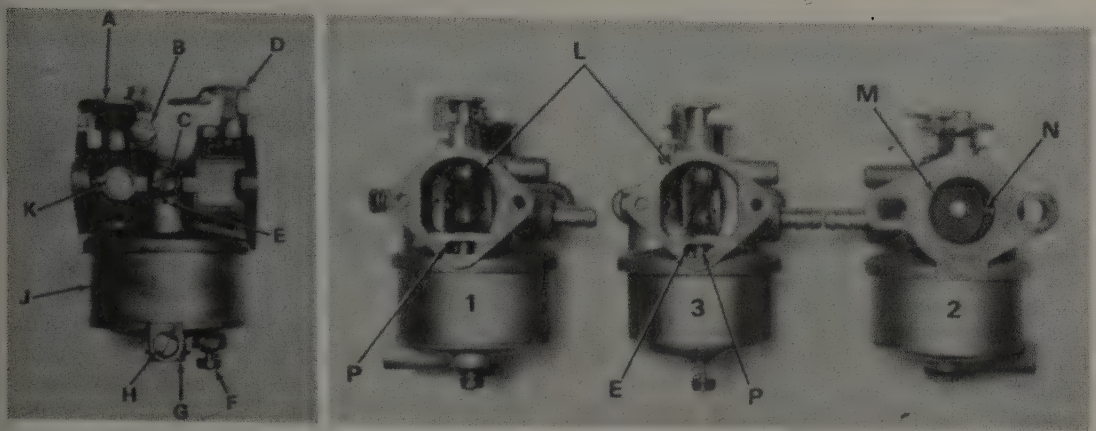
1. Loosen the cable clamp screw so that the engine control cable will slide back and forth.
2. Move the engine control lever on the handle to the FAST position.
3. Move the control cable forward or backward until the choke control lever just touches the carburetor choke, with the choke valve fully open.
4. Tighten the clamp screw.
5. Move the engine control lever to the STOP position and make sure that the choke control lever makes contact with the spring STOP switch. Move the engine control lever to the STOP (CHOKE) position and see if the choke valve is fully closed. If not, redo the adjustments.

DISASSEMBLY

NOTE: *The following overhaul procedure applies to all carburetors used with these engines. Differences among carburetors will be noted where necessary.*

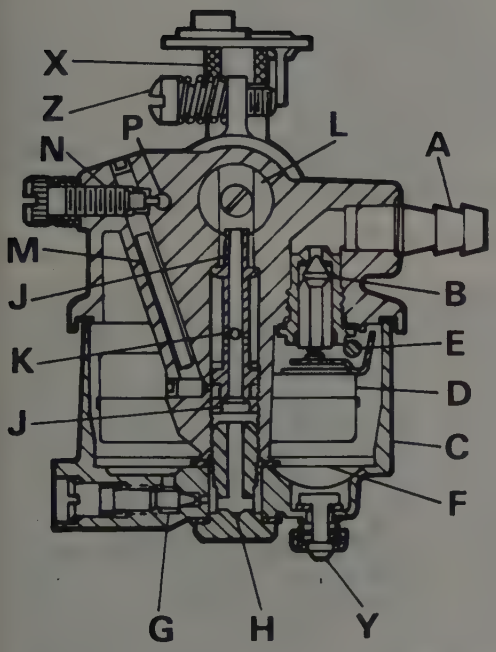


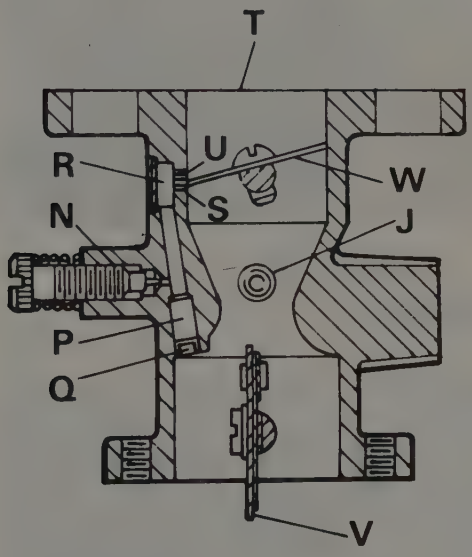
Engine control cable adjustment



A. Throttle plate and throttle shaft assembly
B. Idle speed regulating screw
C. Idle fuel regulating screw
D. Choke plate and choke shaft assembly
E. Atmospheric vent hole
F. Float bowl housing drain valve
G. Float bowl housing retainer screw
H. High-speed adjusting needle
J. Float bowl housing
K. Idle chamber
L. Choke end view of Carburetors 1 and 3 (see Figure 3-23)
M. Throttle plate end view, (all three carburetors)
N. Primary and secondary idle passages, (all three carburetors)
P. Main nozzle air vent hole, (all three carburetors)

The three types of carburetor used





A. Inlet fitting
B. Inlet valve
C. Fuel bowl
D. Float
E. Float hinge pin
F. Filter screen
G. Main adjustment screw
H. Fuel bowl retainer
J. Main nozzle
K. Nozzle air bleed holes
L. Venturi
M. Idle channel
N. Idle fuel adjustment screw
P. Emulsion channel
Q. Idle air pickup hole
R. Idle chamber
S. Secondary idle hole
T. Throttle bore
U. Primary idle hole
V. Choke plate
W. Throttle plate
X. Throttle shaft seal
Y. Drain valve
Z. Idle "RPM" adjusting screw

Cross section of the Walbro carburetor

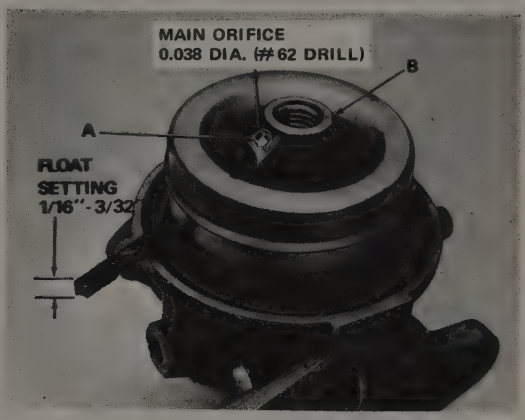
1. Remove the idle fuel regulating screw and the high speed adjustment needle, where applicable.
2. Using a box wrench, remove the brass retaining screw at the bottom of the float bowl housing.
3. Hold the carburetor upsidedown and remove the float bowl housing from the carburetor body.
4. Inspect the housing for dirt or other contaminants. Discard all gaskets.
5. Remove the filter screen in the bowl housing by tapping the bowl lightly on a flat surface.

NOTE: *Fixed jet carburetors do not have a screen.*

6. Remove the hinge pin and lift the float from the carburetor.
7. Using a screwdriver of exactly the right blade size, remove the main metering nozzle from the stem of the carburetor body. Make sure that the four idle bleed holes and the four air bleed holes are not restricted. On fixed jet carburetors, there are six air bleed holes.
8. Remove the brass needle and seat, along with the gasket.
9. Using a safe solvent, clean the carburetor body. Dry the body with a lint-free rag or compressed air.

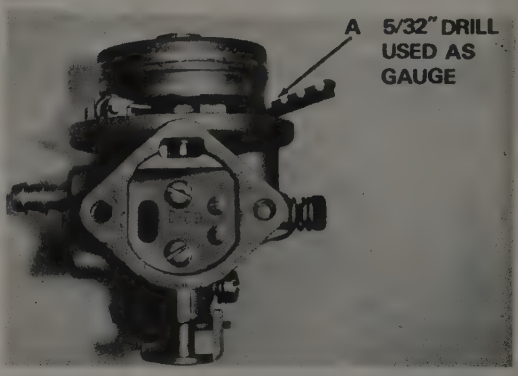
ASSEMBLY

1. Inspect the needle and seat. If any wear is suspected, replace it.
2. Inspect the float. If it appears damaged in any way, or if, when shaking it, any rattling is heard within, replace it.
3. Install the needle and seat with a new gasket.
4. Install the float.
5. If the spring between the needle and float has a fastener, make sure it is connected to the tab on the float.

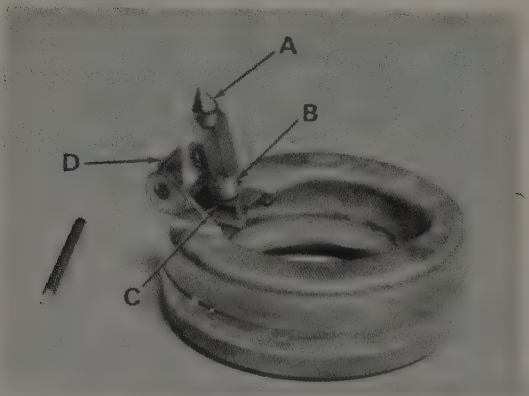


A. Main Orifice (Current Models)
B. Main Orifice (Early Models)

Main orifice

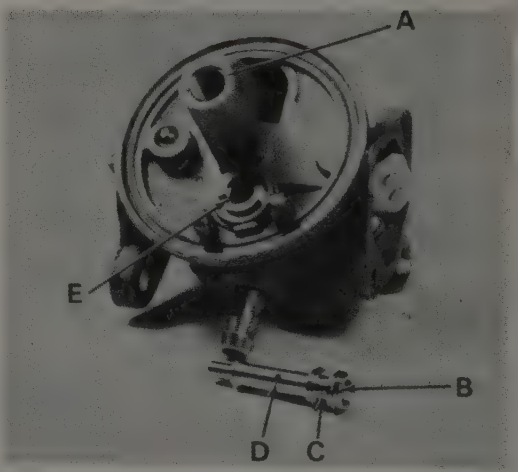


Float adjustment



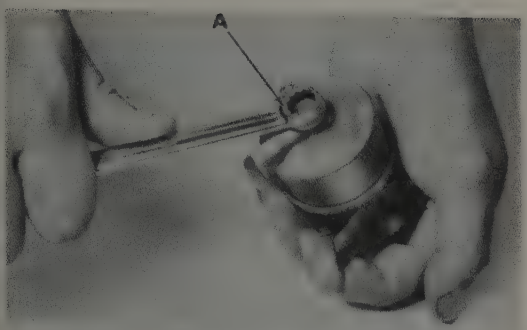
A. Needle
B. Spring
C. Tab
D. Float travel setting

Float, and needle



A. Threaded stem
B. Metering nozzle
C. Idle fuel holes
D. Air bleed holes
E. Brass seat

Meter nozzle installation



A. Retaining Screw

Retainer screw installation

6. Adjust the clearance between the float and the rim of the body casting, to $^5/_{32}$ in., by bending the tab on the float arm. The adjustment is made with the carburetor in an upsidedown position.

NOTE: *On fixed jet carburetors, the float gap is $^1/_{16}$–$^3/_{32}$ in.*

7. Install the metering nozzle.

8. Carefully, install the filter screen in the housing. Make sure that the screen bottoms in the housing.

9. Install a new gasket on the threaded stem of the carburetor body.

10. Place the float bowl housing on the carburetor body with the high speed adjustment needle hole on the same side as the idle adjusting needle hole.

11. Center the inside gasket on the threaded hole by revolving a screwdriver in the retainer screw hole on the float bowl housing. Place a new gasket on the retaining screw and turn the screw in finger tight.

NOTE: *It is very important to further adjustments that the retaining screw be installed securely. Do not, however, tighten it too tightly, as it can strip the threads.*

12. Hold the carburetor in the palm of your hand and tighten the retaining screw with a box wrench until you can feel the carburetor begin digging into the palm of your hand.

13. Install the choke plate and throttle plate.

14. While holding the throttle plate closed, install the idle speed screw until it just contacts the stop on the throttle disc.

15. Install the idle fuel regulating screw. Check the orifice to be sure that the loose wire in the housing is not visible, then turn the screw in until it gently bottoms.

16. Install the high speed adjustment needle until it gently bottoms. Make sure that the screwdriver slot in the needle is aligned with the notch in the housing.

NOTE: *If the alignment cannot be made easily, the screw is overtightened. In this event, you've ruined the float bowl housing. The housing must be replaced.*

ENGINE

NOTE: *The following procedures apply to both the 321 and 501 engines. Where differences in procedure between the two exist, they will be noted.*

Disassembly

GOVERNOR, CARBURETOR AND REED ADAPTER

1. Disconnect the governor and throttle linkage.

2. On the 321, pull out the brass retaining button.

3. Lift the notched, nylon throttle link and disconnect it.

4. Unbolt and remove the carburetor.

5. Remove the four hex-head mounting screws and lift off the reed assembly.

6. Inspect the reeds for proper seating. If there is any noticeable clearance or the reeds appear bent or damaged in any way, replace them.

7. Remove the throttle linkage from the engine backplate.

8. Remove the governor vane.

STARTER

9. Unbolt and remove the starter assembly.

CAUTION: *When working on any recoil starter, safety glasses must be worn. Also, extreme caution must be used, since any misstep can cause the recoil spring to fly out with extreme force, resulting in personal injury.*

Side Pull Types

10. Relax the tension on the starter cord by holding the starter assembly with the pulley up.

11. Pull the starter rope until about 12 inches of rope extends.

12. Hold the pulley steady with thumb pressure and hook the rope with a screwdriver at the point at which it exits the housing.

13. Hold the rope away from the pulley and turn the pulley clockwise with the rope. Allow it to uncoil until the spring is no longer applying tension to the rope.

CAUTION: *When removing the pulley use extreme caution to keep the starter spring confined in the housing.*

NOTE: *Early models use a split pulley sheave, so the tension spring is not enclosed in a case.*

14. Insert a new rope through the pulley and then through the exit hole in the housing.

15. Install the handle grip and tie a knot at both ends of the rope.

16. Pull all the excess rope through the exit hole and grasp the rope where it enters the pulley.

17. Hold the rope securely and wrap the pulley, using spring tension, by pulling the rope counterclockwise 4 revolutions.

18. Hold the pulley stationary with your thumb and remove all slack from the rope. Release the thumb pressure on the pulley and slowly allow the rope to rewind into the pulley.

NOTE: *To avoid spring damage by overwinding, pull the starter rope to its full extent and rotate the starter pulley counterclockwise by hand. If it will not rotate ¼ turn counterclockwise before bottoming out, the spring is overwound and must be relaxed 1 turn.*

19. Install the spring by relaxing tension on the pulley as previously described.

NOTE: *On certain types of starters, the holder slips off the spring as it is installed in the housing. Always install the new spring with the windings in the same direction as the old one. If any damage is suspected to any components, replace it.*

20. The remainder of starter assembly is the reverse of disassembly.

Up-and-Away Starters

21. Relax the tension on the rope by pulling it out about 12 inches. Hold the pulley to prevent it from retracting.

22. Raise the rope with your finger at the point where it exits the housing. Release the pulley and the spring will automatically unwind. The rope can now be removed.

23. Using snap-ring pliers, remove the snap-ring then the pawl lever and pawl.

NOTE: *Since one end of the coil spring is attached to the hub of the pulley, a slight turn, clockwise, may aid in removal.*

24. Lift the cup and recoil spring from the pulley hub.

25. Remove the pulley from the fan housing.

26. Inspect all parts if wear is evident or damage is suspected, replace the parts. Clean all parts in a safe solvent.

27. Assemble the starter is reverse order of disassembly.

NOTE: *When installing the spring cup, make sure that the point at which the spring fastens to the cup is 180° from the hole at which the rope passes through the housing.*

FLYWHEEL

28. On the 321 engine, remove the 4 hex head capscrews securing the starter housing, using a ⅜ in. socket. On horizontal engines, remove the exhaust manifold before removing the housing.

29. Hold the flywheel with a strap wrench.

30. Using an $^{11}/_{16}$ in. socket, remove the flywheel nut, then remove the cupped washer and starter cup.

31. Using another, less valuable nut, place the nut on the end of the crankshaft to protect the threads. Strike this nut sharply with a hammer while applying firm, upward pressure on the flywheel by hand. The flywheel should pop off.

NOTE: *Mishandling of the flywheel could cause damage or loss of magnetism.*

32. Inspect the flywheel for cracks, warping or other damage. Test its magnetic strength by placing a ½ in. socket on the inner rim and gently shaking the flywheel. The socket should not fall off.

STATOR

33. Remove the stator as described in the Tune-Up Section.

BAFFLE AND CYLINDER HEAD

34. Remove the spark plug. Discard it if necessary.

35. Remove the four head bolts.

36. Lift off the baffle and head. Discard the gasket.

37. Check the head for damage, cracks, warping and other problems. Clean the head in a safe solvent.

PISTON AND CONNECTING ROD

NOTE: *Before removing the rod cap, note the metal staking on the cap. When the cap is installed, the screw slots must be staked to lock them in place. If the cap and rod have been disassembled 3 times, they must be replaced.*

38. Place a clean, lint-free cloth under the rear of the engine. This is to catch any of the 28 needle bearings which may fall from the rod cap.

39. Remove the 2 rod cap screws and push the piston and rod out through the bore. COUNT THE NEEDLE BEARINGS!

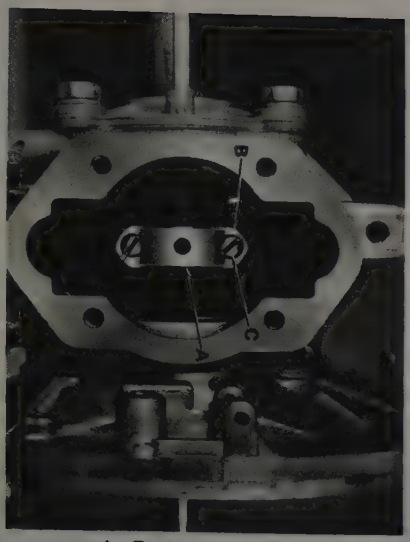
40. If wear is suspected, replace the needle bearings.

41. Remove the piston pin retaining rings.

42. Using a soft drift (brass or wood) tap the pin out of the piston.

43. Inspect the pin and rod for scoring, wear or cracks. If necessary, replace them.

NOTE: *A clogged or faulty air cleaner can cause the pin to develop a concave surface. This can be detected by running your finger the length of the pin. Replace the pin if this condition exists.*



A. Rod cap
B. Metal staking
C. Rod cap screws

Rod cap removal

A. Needle bearings
B. Half circle bearing guides
C. Bearing liners
D. Reference marks

Needle bearings

44. If the pin revolves or even turns slightly in the piston, using finger pressure, replace it.

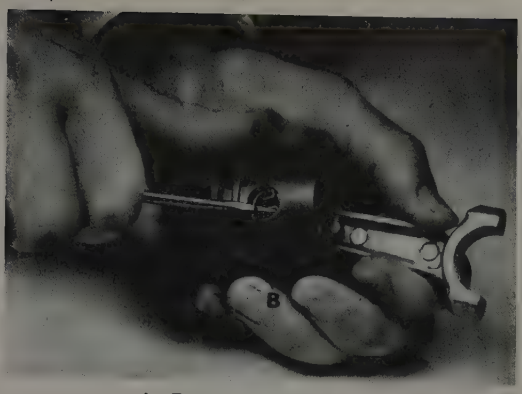
45. Using a ring expander, carefully remove the rings.

46. Check the ring gaps by inserting the rings about ½ inch down the bore. A gap exceeding .070 in. means ring replacement.

47. Check the bore for damage, scoring, wear, scuffing, heat discoloration or any other sign of wear. Remove all carbon from the port areas.

48. Measure the cylinder bore with an inside micrometer. The bore should be 2.1265 in. If the bore is worn more than .003 in. over this, rebore the cylinder or get a new short block. If reboring is done, the bore may be honed up to .020 in. over size. An oversized piston should be used.

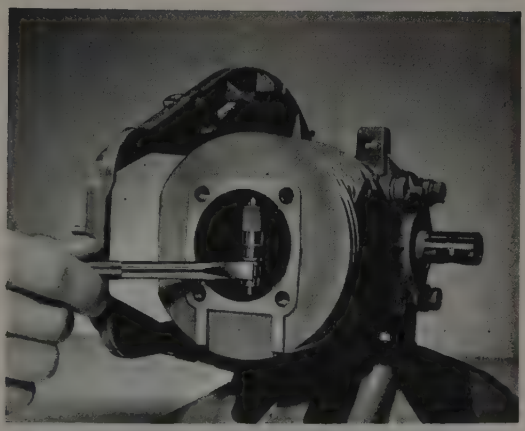
49. When reringing the piston, always use a glaze breaker on the bore to establish a new bore finish.



A. Retaining ring
B. Piston pin (installed)

Removing the piston pin retainer

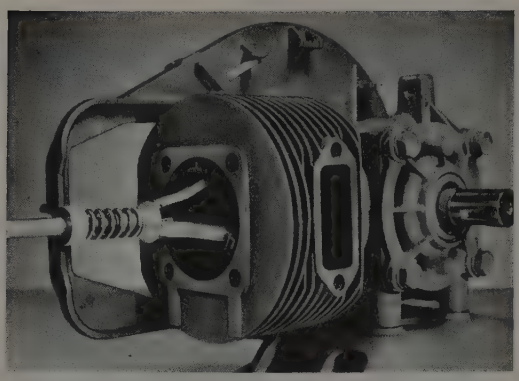
Checking ring gap



Cylinder bore sizing

50. If any damage or excessive wear is noted on the piston, replace it.

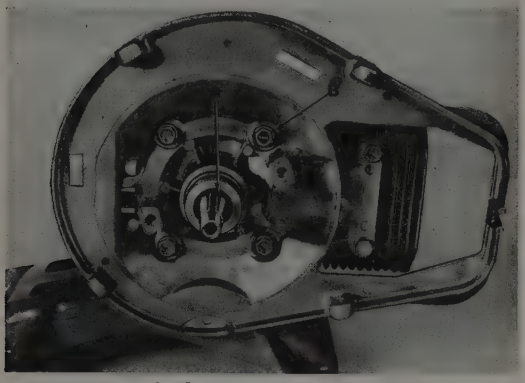
51. Remove all carbon from the ring grooves.



Cylinder hone

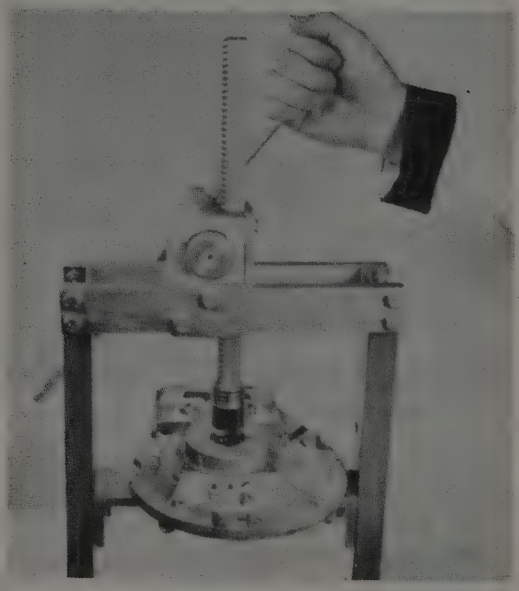
BACKPLATE

52. Insert a seal spreader (supplied as a part of the Jacobsen overhaul kit) in the backplate seal before removing the backplate.



A. Seal spreader
B. Backplate screws

Seal spreader installed



Backplate seal removal

53. Using a ⅜ in. socket, remove the 6 screws attaching the backplate.

54. Place the backplate in an arbor press with the seal facing downward.

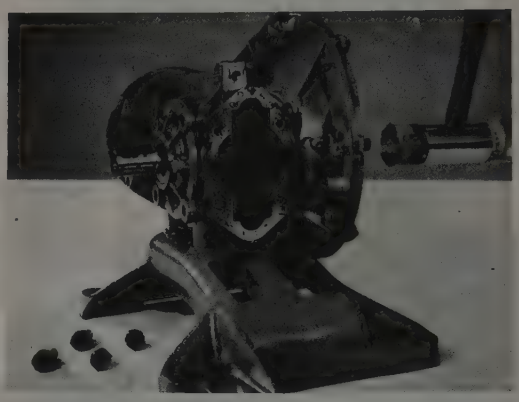
55. Press the bearing out with gradual pressure.

56. Discard the seal.

CRANKCASE HEAD

57. Using a ½ in. socket, remove the 4 hex-head capscrews that secure the crankcase head assembly.

58. With a soft mallet, tap the crankshaft and crankcase head assembly from the engine ignition side.

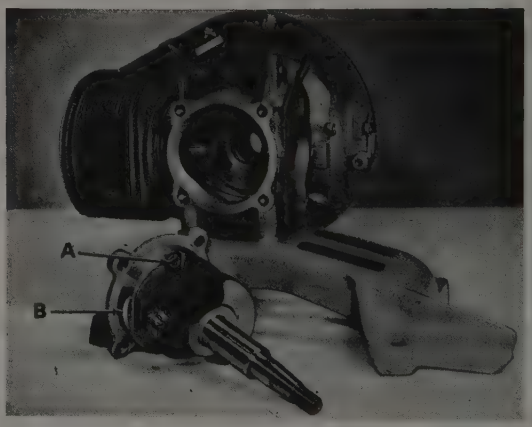


Crankcase head removal

CRANKSHAFT

59. On the 321 engine, use a $^{5}/_{16}$ in. socket to remove the 2 hex-head capscrews and locking tabs. On the 501 engine, remove the snapring.

60. Place the crankcase head in an arbor press with the crankshaft downward. Apply



A. Cap screws and locking tab
B. Flat spot

Crankshaft removal

light, steady pressure until the bearing and crankshaft are pressed out.

61. If the bearings show any sign of wear, replace them. To remove the bearings, remove the retainer and press the bearing off the crankshaft with the arbor press.

Assembly

CRANKSHAFT AND CRANKCASE HEAD

1. Using the arbor press, install the crankshaft bearing and retaining ring.

2. Coat the outside of a new seal with sealer and gently position it until it bottoms. For engines with reduction gear boxes, install the gearbox housing seal in the same manner.

3. Install the crankcase head, making sure that the flat spot on the head faces the cylinder bore. Torque the bolts to 80–100 in. lb.

BACKPLATE

4. Press the bearing into the backplate to a depth of $^3/_{16}$ in. from the surface.

5. Coat the outside of a new seal with sealer and gently seat the seal until it bottoms. Take great care to avoid cocking the seal. Install the backplate and torque the capscrews to 60–80 in. lb.

PISTON AND CONNECTING ROD

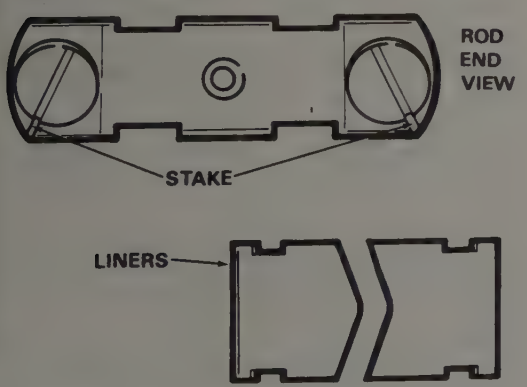
6. Coat all parts with clean engine oil.

7. Place the connecting rod in the piston. Fit the pin through the piston and rod, so that the hole in the pin is on the same side as the flat face of the piston crown. This corresponds to the intake side. The pin may be hammered into place using a brass drift.

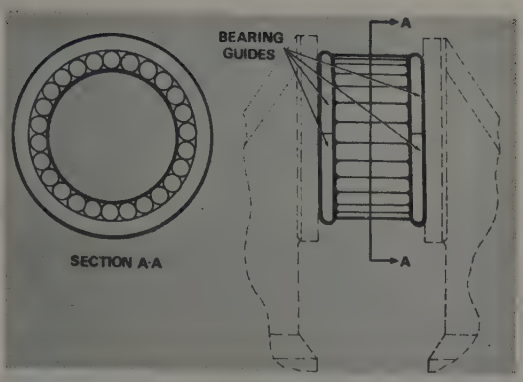
8. Check the pin with a micrometer to make sure that it was not deformed during installation.

9. Install the retaining rings in the piston to secure the pin.

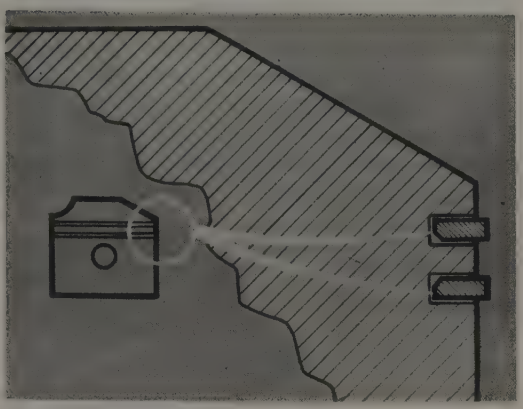
10. Using a ring expander, carefully install the rings so that the chamfered edge of the top ring faces downward, and the chamfered edge of the bottom ring faces upward.



Connecting rod end cap and liners



Needle bearings and bearing guides



Piston ring chamfer

11. The rings must be positioned with the gaps on opposite sides of the piston, prior to installation.

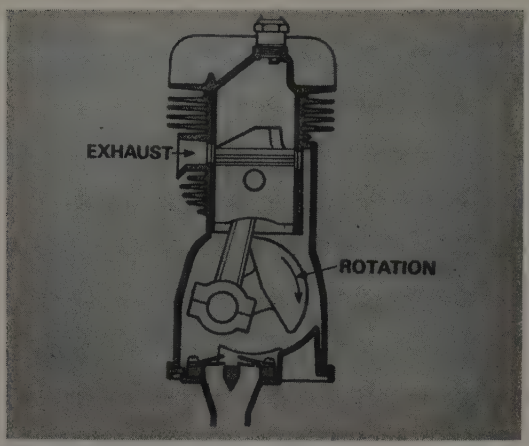
12. Compress the rings with a ring compressor and carefully install the piston and rod assembly into the cylinder bore. Take care to avoid scratching the new bore finish with the rod end. Take care to avoid striking the rod journal with the rod end.

13. The piston assembly should slide in easily. Make sure that the face of the piston crown is on the intake side of the engine. Do not yet seat the rod on the journal.

14. Secure a new needle bearing set. The set is usually sold in a handy pack wherein the bearings are held together in a wax strip. With the strip at 70–80°F, wrap the strip around the crankpin after removing the paper backing.

15. Apply petroleum jelly around the ends of the bearings and slide the semi-circular bearing guides over the ends of the bearings. Four guides are required.

16. Carefully seat the rod over the journal. Install the rod cap. The mating marks (dots)



Correct piston and rod installation

on the rod and cap, must be on the same side. Torque the attaching bolts to 40–50 in. lb. Stake the bolts to prevent loosening. THIS STAKING MUST BE DONE!

CYLINDER HEAD

17. Install the head, using a new gasket. Torque the head bolts, in a cross-wise fashion, to 150–180 in. lb. (12–15 ft. lb.).
18. Install the air baffle.
19. Install the carburetor and stator as described previously.
20. Set the ignition timing.

FLYWHEEL

21. On horizontal engines, install the starter cup, cupped washer and flywheel retaining nut along with the flywheel.

NOTE: *Install the cupped washer with the high portion at the center, facing outward.*

22. Use a strap wrench to hold the flywheel while tightening the nut. Torque the nut to 300–360 in. lb. (25–30 ft. lb.).
23. Install the flywheel starter cowling.

FINAL ASSEMBLY

24. Install the spark plug and torque it to 180–200 in. lb. (15–18 ft. lb.).
25. Install the spark plug wire, making sure it isn't cracked.
26. Install all other parts in reverse order of removal.
27. Check all adjustments.

7

Kohler 4-Stroke

ENGINE IDENTIFICATION

An engine identification plate is mounted on the carburetor side of the engine blower housing. The numbers that are important, as far as ordering replacement parts is concerned, are the model, serial, and specification numbers.

The model number indicates the engine model series. It also is a code indicating the cubic inch displacement and the number of cylinders. The model number K181, for instance, indicates the engine is 18 cu in. in displacement and that it has 1 cylinder. The letters following the model number indicate that a variety of other equipment is installed on the engine. The letters and what they mean are as follows:

- C Clutch model
- G Housed with fuel tank
- H Housed less fuel tank
- P Pump model
- R Reduction gear
- S Electric start
- T Retractable start

NOTE: *A model number without a suffix letter indicates a basic rope start version.*

The specification number indicates a model variation. It indicates a combination of various groups used to build the engine. It may have a letter preceding it which is sometimes important in determining superseding parts. The first two numbers of the specifications number is the code designating the engine model; the remaining numbers are issued in numerical sequence as each new specification is released, for example, 2899, 28100, 28101, etc.

General Engine Specifications

Model	Bore & Stroke (in.)	Displacement	Horsepower
K91	2⅜ × 2	8.86	4.0

The current specification number model code is K91.

The serial number lists the order in which the engine was built. If a change takes place to a model or a specification, the serial number is used to indicate the points at which the change takes place. The first letter or number in the serial number indicates what year the engine was built. The letter prefix to the engine serial number was dropped in 1969 and thereafter the prefix is a number. Engines made in 1969 have either the letter "E" or the number "1." The code is as follows:

- A—1965
- B—1966
- C—1967
- D—1968
- E—1969

First Digit Numbers:

- 1—1969
- 2—1970
- 3—1971
- 4—1972
- 5—1973
- 6—1974

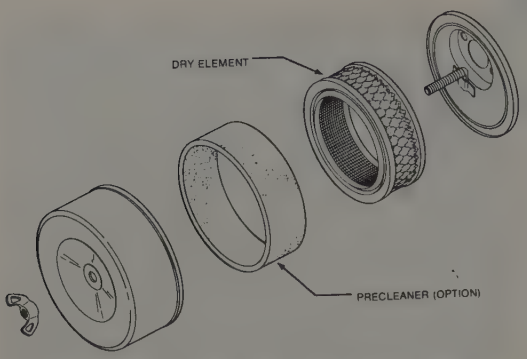
MAINTENANCE

Air Cleaners

A dirty air cleaner can cause rich fuel/air mixture and consequent poor engine operation and sludge deposits. If the filter becomes dirty enough, dirt that otherwise would be trapped can pass through and may wear the engine's moving parts prematurely. It is therefore necessary that all maintenance work be performed precisely as specified.

DRY AIR CLEANERS

Clean dry element air cleaners every 50 hours of operation, or every 6 months (whichever comes first) under good operating conditions.



Exploded view of dry type air cleaner with precleaner

Service more frequently if the operating area is dusty. Remove the element and tap it lightly against a hard surface to remove the bulk of the dirt. If dirt will not drop off easily, replace the element. Do not use compressed air or solvents. Replace the air cleaner every 100–200 hours, under good conditions, and more frequently if the air is dusty.

Observe the following precautions:

1. Handle the element carefully—do not allow the gasket surfaces to become bent or twisted.
2. Make sure gasket surfaces seal against back plate and cover.
3. Tighten wing nut only finger tight—if it is too tight, cleaner may not seal properly.

If the dry type air cleaner is equipped with a precleaner, service this unit when cleaning the paper element. Servicing consists of cleaning the precleaner in soap and water, squeezing the excess out, and then allowing it to air dry before installation. Do not oil!"

OIL BATH AIR CLEANERS

This type of unit may be used to replace the dry type in applications where very frequent replacement of the element is required. The conversion is simple and requires the use of an elbow to fit the oil bath unit onto the engine in a vertical position.

Service the unit every 25 hours of operation under good conditions and, under dusty conditions, as often as every 8 hours of operation. Service as follows:

1. Remove cover and lift element out of bowl.
2. Drain dirty oil from bowl, and then wash thoroughly in clean solvent.
3. Swish the element in the solvent and then allow it to drip dry. *Do not dry with compressed air.* Lightly oil the element with engine oil.
4. Inspect air horn, filter bowl, and cover gaskets, and replace as necessary (if grooved or cracked).
5. Install filter bowl gasket on air horn, then put the bowl into position. Fill bowl to indicated level with engine oil.
6. Install element, put the cover in position, and then install copper gasket (if used) and wingnut. Tighten wingnut with fingers only to avoid distorting housing. Make sure all joints in the unit seal tightly.

Lubrication

CRANKCASE

Oil level must be maintained between F and L marks—do not overifll. Check every day and add as necessary. On new engines, be especially careful to stop engine and check level frequently. When checking, make sure regular type dipstick is inserted fully. On screw type dipstick, check level with dipstick inserted fully but *not* screwed in. On this type, however, make sure to screw dipstick back in tightly when oil level check is completed.

Use SC type oils meeting viscosity specifications according to the prevailing temperature as shown in the chart below.

Oil Viscosity Chart

Air Temperature	Oil Viscosity	Oil Type
Above 30° F	SAE 30	API Service SC*
30° to 0° F	SAE 10W-30	API Service SC*
Below 0° F	SAE 5W-20	API Service SC*

*SC standard recommendation—CC (MIL-2104B) and SD class oils may also be used.

Change initial fill of oil on new engines after five hours of operation. Then, change oil every 25 hours of operation. Change oil when engine is hot. Change more frequently in dusty areas. If the engine has just been overhauled, it is best to fill it initially with a non-detergent oil. Then, after 5 hours, refill with SC type oil.

Oil capacities are:

- K91—½ qt.

REDUCTION GEAR UNITS

Every 50 hours, remove the oil plug on the lower part of the reduction unit cover to check level. If oil does not reach the level of the oil plug, remove the vented fill plug from the top of the cover and refill with engine oil until level is correct. This oil need not be changed unless unit has been out of service for several months. In this situation, remove the drain plug, drain oil, then replace plug and fill to proper level as described above.

FUEL RECOMMENDATIONS

Use either leaded or unleaded regular grade fuel of at least 90 octane. Unleaded fuel produces fewer combustion chamber deposits, so its use is preferred.

Purchase fuel from a reputable dealer, and make sure to use only fresh fuel (fuel less than 30 days old). If the engine is stored, drain the fuel system or use a fuel stabilizer that is compatible with the type of fuel tank the engine is equipped with.

TUNE-UP

Spark Plugs

SERVICE

The spark plug should be removed and serviced every 100 hours of engine operation. The plug should have a light coating of light gray colored deposits. If deposits are black, fuel/air mixture could be too rich due to improper carburetor adjustment or a dirty air cleaner. If deposits are white, the engine may be overheating or a spark plug of too high a heat range could be in use.

Kohler recommends that the plug be replaced rather than sandblasted or scraped if there are excessive deposits. Torque plugs to 18–22 ft. lbs.

TESTING

To test a plug for adequate performance, remove it from the engine, attach the ignition wire, and then rest the side electrode against the cylinder head. Crank the engine vigorously. If there is a sharp spark, the plug and ignition system are allright, although ignition timing should be checked if the engine fires irregularly.

Breaker Points

INSPECTION

Remove the breaker cover and inspect the points for pitting or buildup of metal on either the movable or stationary contact every 100 hours of operation. Replace the points if they are badly burned. If there is a great deal of metal buildup on either contact, the condenser may be faulty and should be replaced.

To replace points, remove the primary wiring connector screw and pull off the primary wire. Then, remove the contact set mounting screws and remove the contact set. Install the new set of points in reverse order, leaving upper mounting screw slightly loose. Then set point gap and timing as described below.

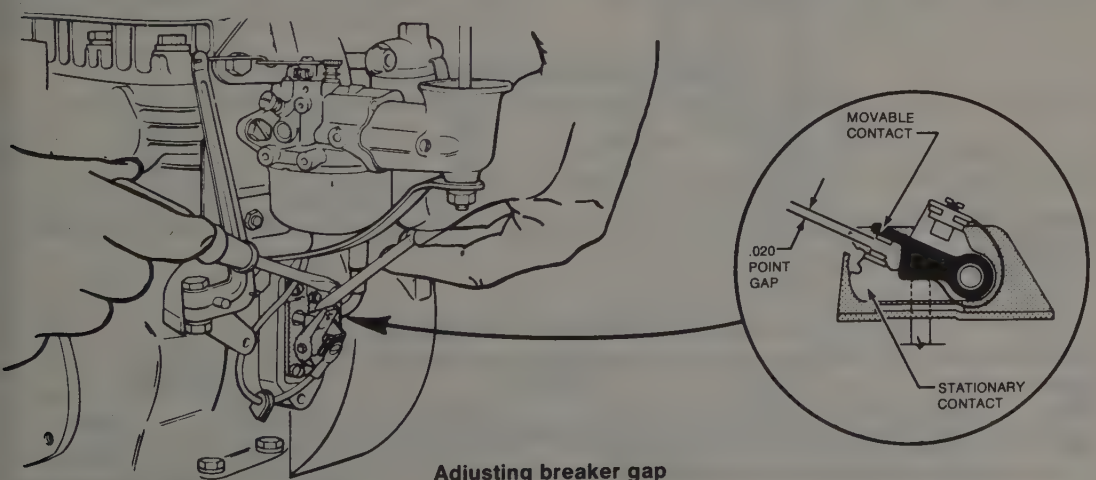
SETTING BREAKER GAP AND TIMING

1. Remove the breaker cover and disconnect the spark plug lead. Rotate the engine in direction of normal rotation until the points reach the maximum opening.

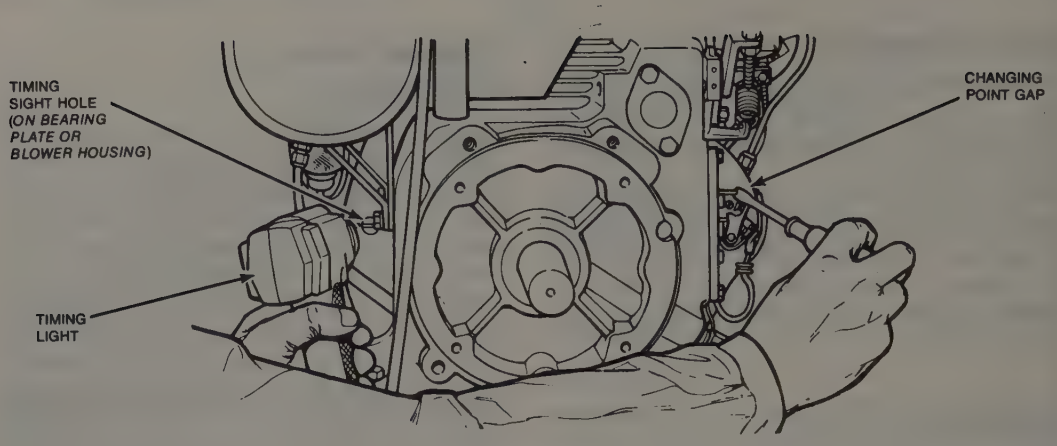
2. Using a clean, flat feeler gauge of .020″ size, check the gap between the points. Gauge should just slide between the contacts without opening them when flat between them. If the gap is incorrect, loosen the upper mounting screw (if necessary), and shift the breaker base with the blade of the screwdriver until gap is correct.

3. There is a timing sight hole in either the bearing plate or the blower housing. If there is a snap button in the hole, pry it out with a screwdriver.

4. While observing the sight hole, turn the engine slowly in normal direction of rotation. When the T mark appears in the hole, the points should just be beginning to open. If timing is incorrect, breaker gap will have to be reset slightly (.018–.022 in.). If the points



Adjusting breaker gap



Adjusting timing

are not yet opening when the timing mark is centered in the hole, make the point gap wider. If points open too early, narrow it. Recheck the setting after tightening the upper breaker mounting screw by turning the engine in normal direction of rotation past the firing point and checking that the points open at just the right time.

NOTE: *This procedure may be performed with the engine running at 1,200–1,800 rpm if a timing light is available. Connect the timing light according to manufacturer's instructions. You may have to chalk the timing mark to see it adequately.*

TRIGGER AIR GAP

Trigger air gap is set within the range .005–.010 in. As long as the gap falls within this range, the ignition system should perform adequately. Optimum ignition performance during cold weather starting is provided if the gap is adjusted to .005 in. If you wish to adjust this or to ensure that the gap falls within the proper range, rotate the flywheel until the flywheel projection is lined up with the trigger assembly. Then, loosen the trigger bracket capscrews and slide the trigger back and forth to get the proper gap, as measured with a flat feeler gauge. Then, retighten capscrews.

IGNITION COILS

Coils do not require regular service, except to make sure they are kept clean, that the connections are tight, and that rubber insulators are in good condition (replace if cracked). If you suspect poor performance of a breakerless type ignition system and trigger air gap is correct, check resistance with an ohmmeter. To do this, disconnect the high tension lead at the coil and connect the meter between coil terminal and coil mounting bracket. If resistance is not about 11,500 ohms, replace the coil. Also, check the reading with the meter lead going to the coil terminal pulled off and connected to the spark plug connector of the high tension lead. If there is continuity here, replace the coil.

PERMANENT MAGNETS

These may be checked for magnet strength by holding a screwdriver (non-magnetic) blade within one inch of the magnet. If the magnetic

Tune-Up Specifications

Model	Plug Gap (in.)	Breaker Point Gap (in.)	Trigger Air Gap (in.)	Normal Timing (deg)	Retard Timing (deg)
K91	.025①	.020	—	20B	—

B—Before
① Shielded plug gap—.020 in.

Spark Plug Specifications

Engine Model	Plug Size	Hex Size	Plug Reach	Standard Plugs		Resistor Plugs	
				Solid Post	Knurled Nut	Non-Shielded	Shielded
K91	14 mm	13/16"	3/8"	J-8 270321-S	J-8 220040-S	XJ-8 232604-S	XEJ-8 220258-S

field is good, the blade will be attracted to the magnet. Otherwise, replace it.

Mixture Adjustments

NOTE: *Before making any adjustments, be sure that the carburetor air cleaner is not clogged. A clogged air cleaner will cause an over-rich mixture, black exhaust smoke, and may lead you to believe that the carburetor is out of adjustment when, in reality, it is not. The carburetor is set at the factory and rarely needs adjustment unless, of course, it has been disassembled or rebuilt.*

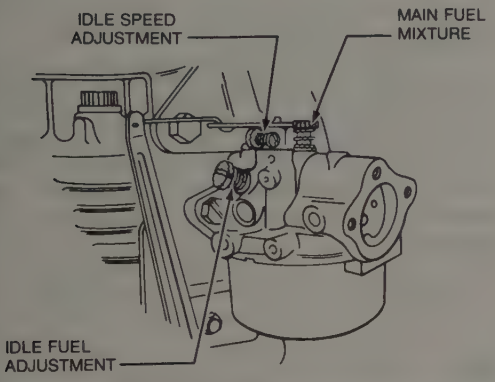
1. With the engine stopped, turn the main and idle fuel adjusting screws all the way in until they bottom *lightly*. Do not force the screws or you will damage the needles.

2. For a preliminary setting, turn the main fuel screw out 2 full turns and the idle screw out 1¼ turns.

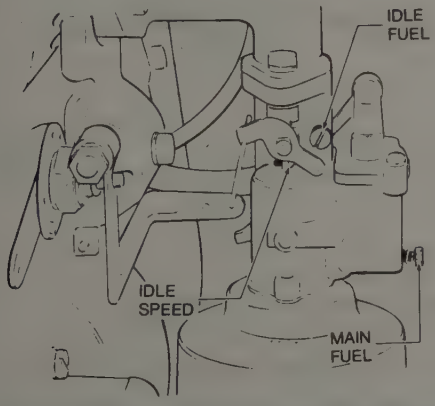
3. Start the engine and allow it to reach operating temperatures; then operate the engine at full throttle and under a load, if possible.

4. For final adjustment, turn the main fuel adjustment screw in until the engine slows down (lean mixture), then out until it slows down again (rich mixture). Note the positions of the screw at both settings, then set it about halfway between the two positions.

5. Set the idle mixture adjustment screw in the same manner. The idle speed (no-load) on most engines is 1200 rpm; however, on engines with a parasitic load (hydrastatic drives) the engine idle speed may have to be increased to as much as 1700 rpm for best no-load idle.



Adjustment screws on the side draft carburetor



Adjustment screws on the updraft carburetor

Governor Adjustment

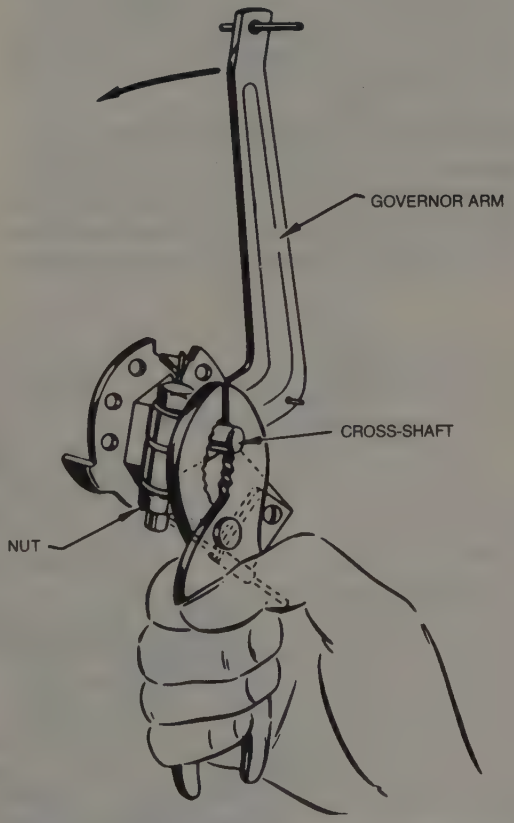
All Kohler engines use mechanical, camshaft driven governors.

INITIAL ADJUSTMENT

1. Loosen, but do not remove, the nut that holds the governor arm to the governor cross shaft.

2. Grasp the end of the cross shaft with a pair of pliers and turn it in counterclockwise as far as it will go. The tab on the cross shaft will stop against the rod on the governor gear assembly.

3. Pull the governor arm away from the carburetor, then retighten the nut which holds the governor arm to the shaft. With updraft



Initial adjustment of the governor installed on the K91, K141, K161, and the K181 engines

carburetors, lift the arm as far as possible, then retighten the arm nut.

FINAL ADJUSTMENT

After making the initial adjustment and connecting the throttle wire on the variable speed applications, start the engine and check the maximum operating speed with a tachometer. If adjustment is necessary:

1. Loosen the bushing nut slightly.
2. Move the throttle bracket in a counterclockwise direction to increase speed, or in a clockwise direction to decrease engine speed. Maximum speed is 4000 rpm.
3. With the speed set to the proper range, tighten the bushing nut to lock the throttle bracket in position.

Choke Adjustment

THERMOSTATIC TYPE

If the engine does not start when cranked, continue cranking and move the choke lever first to one side and then to the other to determine whether the setting is too lean or too rich. Once the direction in which lever must be moved has been determined, loosen the adjusting screw on the choke body. Then, move the bracket downward to increase choking or upward to decrease it. Then, tighten the lockscrew. Try starting it again and readjust as necessary.

ELECTRIC-THERMOSTATIC TYPE

Remove the air cleaner from the carburetor and check the position of the choke plate. The choke should be fully closed when engine is at outside temperature and the temperature is very low. In milder temperatures, slightly less closure is required.

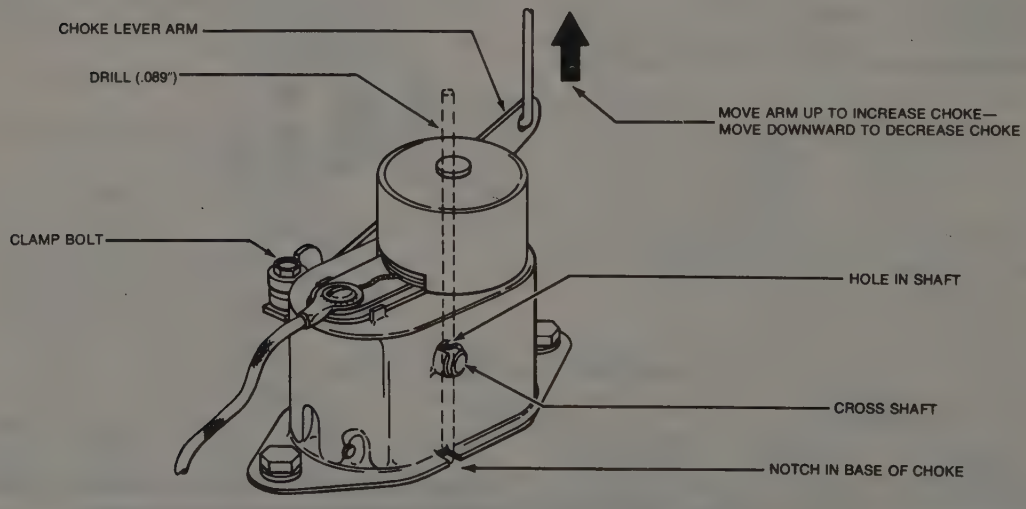
If adjustment is required, move the choke arm until the hole in the brass shaft lines up with the slot in the bearings. Insert a #43 (.089 in.) drill through the shaft and push it downward so it engages the notch in the base of the choke unit. Then, loosen the clamp bolt on the choke lever and push the arm upward to move the choke plate toward the closed position. When the desired position is obtained, tighten the clamp bolt. Then, remove the drill.

Remount the air cleaner, and then check for any binding in the choke linkage. Correct as necessary. Finally, run the engine until hot, and make sure the choke opens fully. If not, readjust it toward the open position as necessary.

Compression Check

Compression is checked by removing the spark plug lead and spinning the flywheel forward against compression. If the piston does not bounce backward with considerable force, checking with a gauge may be necessary. On Automatic Compression Release engines, rotate the flywheel backward against power stroke—if little resistance is felt, check compression with a gauge.

The compression gauge check requires rapid motoring (spinning) of the crankshaft, at about 1,000 rpm. Install the gauge in the spark plug hole and motor the engine. Gauge should read 110–120 psi. If reading is less than 100 psi, the engine requires major repair to piston rings or valves.



Adjusting electric-thermostatic choke

FUEL SYSTEM

Carburetor

If a carburetor will not respond to mixture screw adjustments, then you can assume that there are dirt, gum, or varnish deposits in the carburetor or worn/damaged parts. To remedy these problems, the carburetor will have to be completely disassembled, cleaned, and worn parts replaced and reassembled.

Parts should be cleaned with solvent to remove all deposits. Replace worn parts and use all new gaskets. Carburetor rebuilding kits are available.

DISASSEMBLY

Side Draft Carburetors

1. Remove the carburetor from the engine.
2. Remove the bowl nut, gasket, and bowl. If the carburetor has a bowl drain, remove the drain spring, spacer and plug, and gasket from inside the bowl.
3. Remove the float pin, float, needle, and needle seat. Check the float for dents, leaks, and wear on the float lip or in the float pin holes.
4. Remove the bowl ring gasket.
5. Remove the idle fuel adjusting needle, main fuel adjusting needle, and springs.
6. Do not remove the choke and throttle plates or shafts. If these parts are worn, replace the entire carburetor assembly.

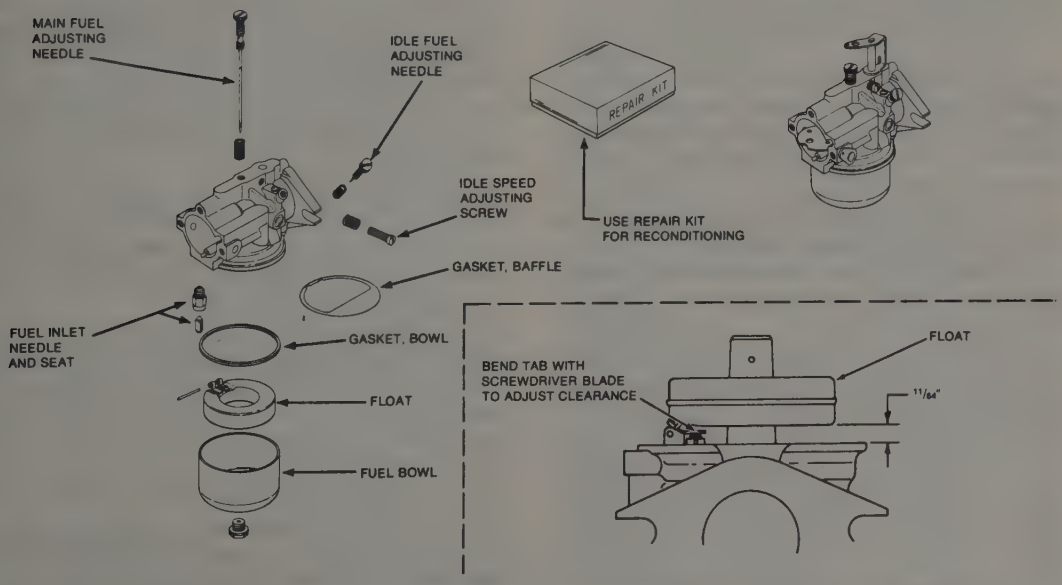
Updraft Carburetors

1. Remove the carburetor from the engine.
2. Remove the bowl cover and the gasket.
3. Remove the float pin, float, needle and needle seat. Check the float pin for wear.
4. Remove the idle fuel adjustment needle, main fuel adjustment needle, and the springs. Do not remove the choke plate or the shaft unless the replacement of these parts is necessary.

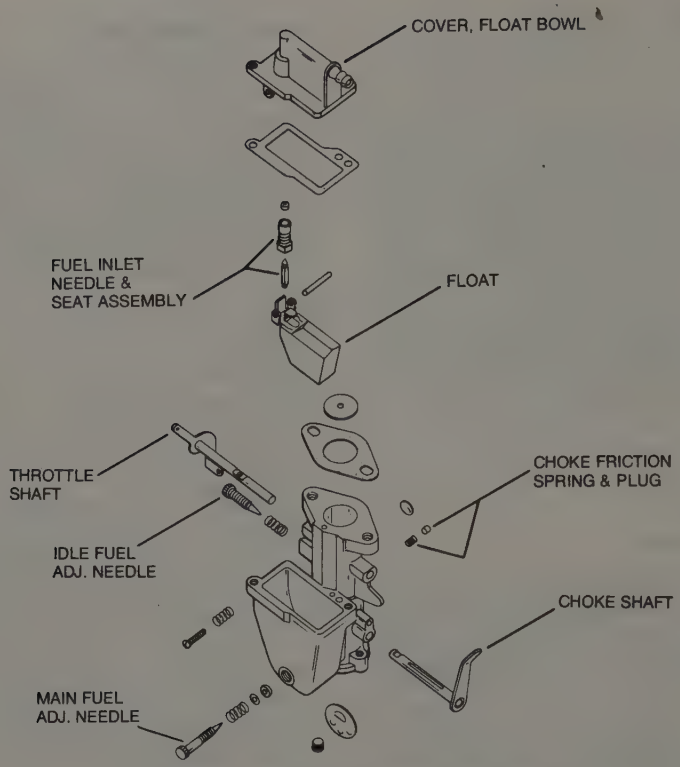
ASSEMBLY

Side Draft Carburetor

1. Install the needle seat, needle, float, and float pin.
2. Set the float level. With the carburetor casting inverted and the float resting against the needle in its seat, there should be $^{11}/_{64}$ in. plus or minus $^{1}/_{32}$ in. clearance between the machined surface of the casting and the free end of the float.
3. Adjust the float level by bending the lip of the float with a small screwdriver.
4. Install the new bowl ring gasket, new bowl nut gasket, and bowl nut. Tighten the nut securely.
5. Install the main fuel adjustment needle. Turn it in until the needle seats in the nozzle and then back out two turns.
6. Install the idle fuel adjustment needle. Back it out about 1¼ turns after seating it lightly against the jet.
7. Install the carburetor on the engine.



Exploded view of the sidedraft carburetor. Inset shows float adjustment procedure



Exploded view of the updraft carburetor

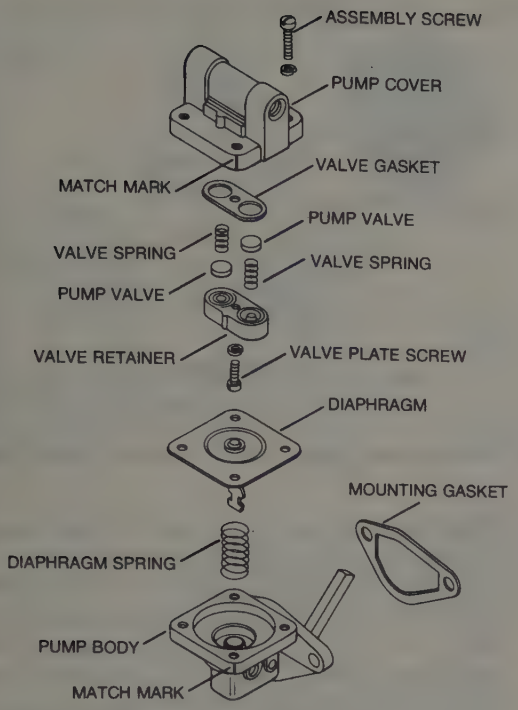
Updraft Carburetor

1. Install the throttle shaft and plate. The elongated side of the valve must be toward the top.
2. Install the needle seat. A $^{5}/_{16}$ in. socket should be used. Do not over-tighten.
3. Install the needle, float, and float pins.
4. Set the float level. With the bowl cover casting inverted and the float resting lightly against the needle in its seat, there should be $^{7}/_{16}$ in. plus or minus $^{1}/_{32}$ in. clearance between the machined surface casting and the free end of the float.
5. Adjust the float level by bending the lip of the float with a small screwdriver.
6. Install the new carburetor bowl gasket, bowl cover, and bowl cover screws. Tighten the screws securely.
7. Install the main fuel adjustment needle. Turn it in until the screw seats in the nozzle and then back it out 2 turns.
8. Install the idle fuel adjustment needle. Back it out about 1½ turns after seating the screw lightly against the jet. Install the idle speed screw and spring. Adjust the idle to the desired speed with the engine running.
9. Install the carburetor on the engine.

Fuel Pump

Fuel pumps used on single cylinder Kohler engines are either the mechanical or vacuum actuated type. The mechanical type is operated by an eccentric on the camshaft and the vacuum type is operated by the pulsating negative pressures in the crankcase. The K91 vacuum type pump is not serviceable and must be replaced when faulty. The mechanical pump is serviceable and rebuilding kits are available.

1. Disconnect fuel lines, remove mounting screws, and pull the pump off the engine.
2. File a mark across some point at the union of pump body and cover. Remove the screws and remove the cover.
3. Turn the cover upside down and remove the valve plate screw and washer. Remove the valve retainer, valves, valve springs, and valve gasket, after noting the position of each part. Discard the valve springs, valves and valve retainer gasket.
4. Clean the fuel head with solvent and a soft wire brush. Hold the pump cover with the diaphragm surface upward; position a new gasket into the cavity. Put the valve spring and valves into position in the cavity and reassem-



Exploded view of the fuel pump

ble the valve retainer. Lock the retainer into position by installing the fuel pump valve retainer screw.

5. Rebuild the lower diaphragm section.

6. Hold the mounting bracket and press down on the diaphragm to compress the spring underneath. Turn the bracket 90 degrees to unhook the diaphragm and remove it.

7. Clean the mounting bracket with solvent and a wire brush.

8. Stand a new diaphragm spring in the casting, put the diaphragm into position, and push downward to compress the spring. Turn the diaphragm 90 degrees to reconnect it.

9. Position the pump cover on top of the mounting bracket with the indicating marks lined up. Install the screws loosely on mechanical pumps; on vacuum pumps, tighten the screws.

10. Holding only the mounting bracket, push the pump lever to the limit of its travel, hold it there, and then tighten the four screws.

11. Remount the fuel pump on the engine with a new gasket, tighten the mounting bolts, and reconnect the fuel lines.

ENGINE OVERHAUL

Disassembly

The following procedure is designed to be a general guide rather than a specific and all inclusive disassembly procedure. The sequence may have to be varied slightly to allow for the removal of special equipment or accessory items such as motor/generators, starters, instrument panels, etc.

1. Disconnect the high tension spark plug lead and remove the spark plug.

2. Close the valve on the fuel sediment bowl and remove the fuel line at the carburetor.

3. Remove the air cleaner from the carburetor intake.

4. Remove the carburetor.

5. Remove the fuel tank. The sediment bowl and brackets remain attached to the fuel tank.

6. Remove the blower housing, cylinder baffle, and head baffle.

7. Remove the rotating screen and the starter pulley.

8. The flywheel is mounted on the tapered portion of the crankcase and is removed with the help of a puller. Do not strike the flywheel with any type of hammer.

9. Remove the breaker point cover, breaker point lead, breaker assembly, and the push-rod that operates the points.

10. Remove the magneto assembly.

11. Remove the valve cover and breather assembly.

12. Remove the cylinder head.

13. Raise the valve springs with a valve spring compressor and remove the valve spring keepers from the valve stems. Remove the valve spring retainers, springs, and valves.

14. Remove the oil pan base and unscrew the connecting rod can screws. Remove the connecting rod cap and piston assembly from the cylinder block.

NOTE: *It will probably be necessary to use a ridge reamer on the cylinder walls before removing the piston assembly, to avoid breaking the piston rings.*

15. Remove the crankshaft, oil seals and, if necessary, the anti-friction bearings.

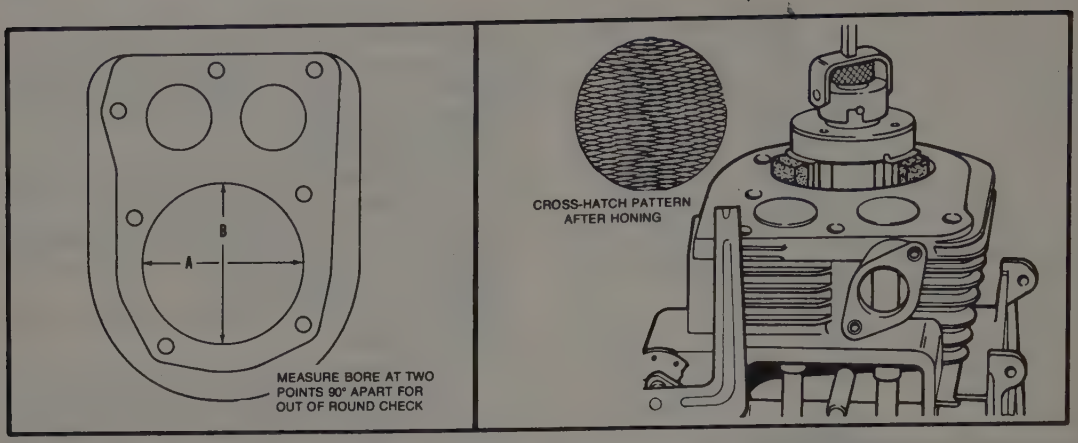
NOTE: *It may be necessary to press the crankshaft out of the cylinder block. The bearing plate should be removed first, if this is the case.*

16. Turn the cylinder block upside down and drive the camshaft pin out from the power take-off side of the engine with a small punch. The pin will slide out easily once it is driven free of the cylinder block.

17. Remove the camshaft and the valve tappets.

18. Loosen and remove the governor arm from the governor shaft.

19. Unscrew the governor bushing nut and



Left side—measuring the cylinder bore. Right side—honing must produce a cross-hatch pattern as shown

remove the governor shaft from the inside of the cylinder block.

20. Loosen, but do not remove, the screw located at the lower right of the governor bushing nut until the governor gear is free to slide off of the stub shaft.

Engine Rebuilding

CYLINDER BLOCK SERVICE

Make sure that all surfaces are free of gasket fragments and sealer materials. The crankshaft bearings are not to be removed unless replacement is necessary. One bearing is pressed into the cylinder block and the other is located in the bearing plate. If there is no evidence of scoring or grooving and the bearings turn easily and quietly it is not necessary to replace them.

The cylinder bore must not be worn, tapered, or out-of-round more than 0.005 in. Check at two locations 90 degrees apart and compare with specifications. If it is, the cylinder must be rebored. If the cylinder is very badly scored or damaged it may have to be replaced, since the cylinder can only be rebored to either 0.010 in. or 0.020 in. and 0.030 in. maximum. Select the nearest suitable oversize and bore it to that dimension. On the other hand, if the cylinder bore is only slightly damaged, only a light deglazing may be necessary.

HONING THE CYLINDER BORE

1. The hone must be centered in relation to the crankshaft crossbore. It is best to use a low speed drill press. Lubricate the hone with kerosene and lower it into the bore. Adjust the stones so they contact the cylinder walls.

2. Position the lower edge of the stones even with the lower edge of the bore, hone at about 600 rpm. Move the hone up and down continuously. Check bore size frequently.

3. When the bore reaches a dimension .0025 in. smaller than desired size, replace the coarse stones with burnishing stones. Use burnishing stones until the dimension is within .0005 in. of desired size.

4. Use finishing stones and polish the bore to final size, moving the stones up and down to get a 60 degree cross-hatch pattern. Wash the cylinder wall thoroughly with soap and water, dry, and apply a light coating of oil.

CRANKSHAFT SERVICE

Inspect the keyway and the gears that drive the camshaft. If the keyways are badly worn or chipped, the crankshaft should be replaced. If the cam gear teeth are excessively worn or if any are broken, the crankshaft must be replaced.

Check the crankpin for score marks or metal pickup. Slight score marks can be removed with a crocus cloth soaked in oil. If the crankpin is worn more than 0.002 in., the crankshaft is to be either replaced or the crankpin reground to 0.010 in. undersize. If the crankpin is reground to 0.010 in. undersize, a 0.010 in. undersize connecting rod must be used to achieve proper running clearance.

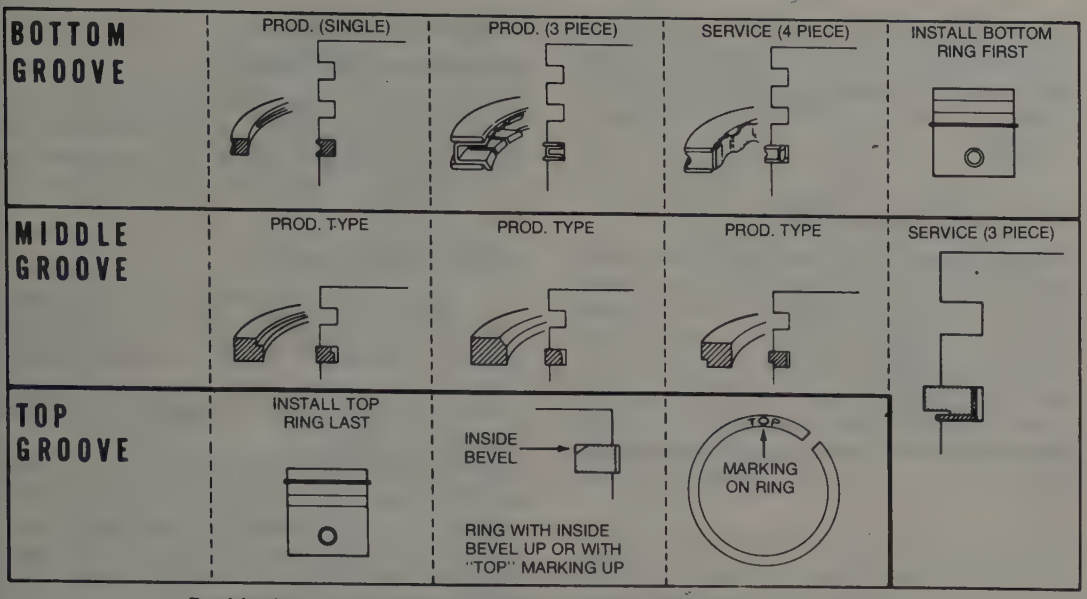
CONNECTING ROD SERVICE

Check the bearing area for wear, score marks, and excessive running and side clearance. Replace the rod and cap if they are worn beyond the limits allowed.

PISTON AND RINGS SERVICE

Production and Service Type

Rings are available in the standard size as well as 0.010 in., 0.020 in., and 0.030 in. oversize sets.



Positioning of production and service type piston rings on the piston

NOTE: *Never reuse old rings.*

The standard size rings are to be used when the cylinder is not worn or out-of-round. Oversize rings are only to be used when the cylinder has been rebored to the corresponding oversize. Service type rings are used only when the cylinder is worn but within the wear and out-of-round limitations; wear limit is 0.005 in. oversize and out-of-round limit is 0.004 in.

The old piston may be reused if the block does not need reboring and the piston is within wear limits. Never reuse old rings. After removing old rings, thoroughly remove deposits from ring grooves. New rings must each be positioned in its running area of the cylinder bore for an end clearance check, and each must meet specifications.

The cylinder must be deglazed before replacing the rings. If chrome plated rings are used, the chrome plated ring must be installed in the top groove. Make sure that the ring grooves are free from all carbon deposits. Use a ring expander to install the rings. Then check side clearance.

PISTON AND ROD SERVICE

Normally very little wear will take place at the piston boss and piston pin. If the original piston and connecting rod can be used after rebuilding, the piston pin may also be used. However if a new piston or connecting rod or both have to be used, a new piston pin must also be installed. Lubricate the pin before installing it with a loose to light interference fit. Use new piston pin retainers whether or not the pin is new. Make sure they're properly engaged.

VALVES AND VALVE MECHANISM SERVICE

Inspect the valve mechanism, valves, and valve seats or inserts for evidence of wear, deep pitting, cracks or distortion. Check the clearance between the valve stems and the valve guides.

Valve guides must be replaced if they are worn beyond the limit allowed. K91 model engines do not use valve guides. To remove valve guides, press the guide down into the valve chamber and carefully break off the protruding end until the guide is completely removed. Be careful not to damage the block when removing the old guides. Use an arbor press to install the new guides. Press the new guides to the depth specified, then use a valve guide reamer to gain the proper inside diameter.

Make sure that replacement valves are the correct type (special hard faced valves are needed in some cases). Exhaust valves are always hard faced.

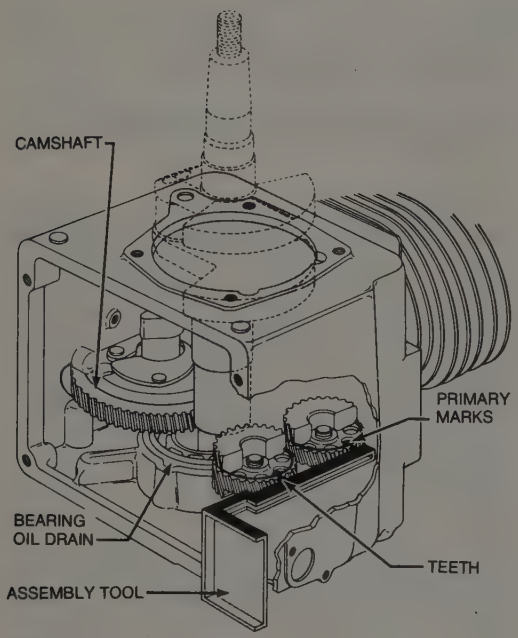
Intake valve seats are usually machined into the block, although inserts are used in some engines. Exhaust valve seats are made of special hardened material. The seating surfaces should be held as close to 1/32 in. in width as possible. Seats more than 1/16 in. wide must be reground with 45° and 15° cutters to obtain the proper width. Reground or new valves and seats must be lapped in for a proper fit.

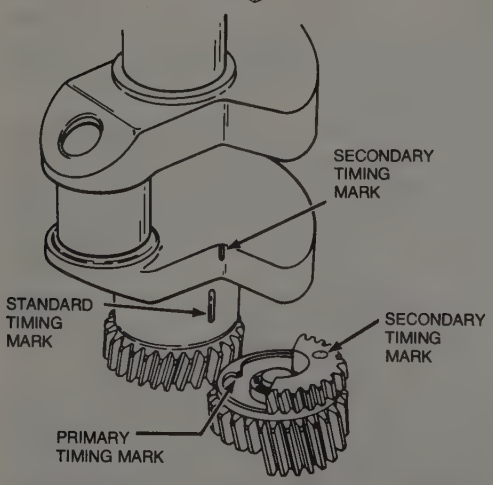
After resurfacing valves and seats and lapping them in, check the valve clearance. Hold the valve down on its seat and rotate the camshaft until it has no effect on the tappet, then check the clearance between the end of the

valve stem and the tappet. If the clearance is not sufficient (it will always be less after grinding), it will be necessary to grind off the end of the valve stem until the correct clearance is obtained.

CYLINDER HEAD SERVICE

Remove all carbon deposits and check for pitting from hot spots. Replace the head if metal has been burned away because of head gasket leakage. Check the cylinder head for flatness. If the head is slightly warped, it can be resurfaced by rubbing it on a piece of sandpaper placed on a flat surface. Be careful not to nick or scratch the head when removing carbon deposits.





Timing marks for the dynamic balance system

Engine Assembly

REAR MAIN BEARING

Install the rear main bearing by pressing it into the cylinder block with the shielded side toward the inside of the block. If it does not have a shielded side, then either side may face inside.

GOVERNOR SHAFT

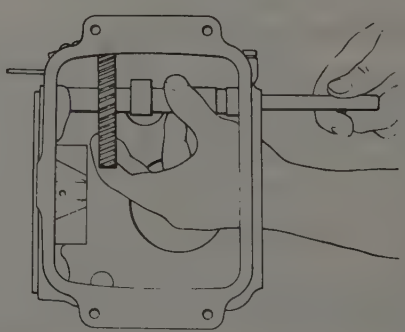
1. Place the cylinder block on its side and slide the governor shaft into place from the inside of the block. Place the speed control disc on the governor bushing nut and thread the nut into the block, clamping the throttle bracket into place.
2. There should be a slight end-play in the governor shaft and that can be adjusted by moving the needle bearing in the block.
3. Place a space washer on the stub shaft and slide the governor gear assembly into place.
4. Tighten the holding screw from outside the cylinder block.
5. Rotate the governor gear assembly to be sure that the holding screw does not contact the weight section of the gear.

CAMSHAFT

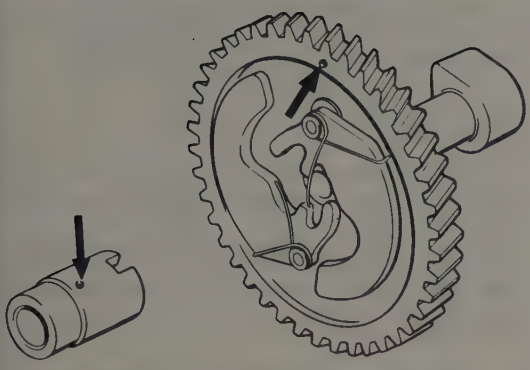
1. Turn the cylinder block upside down.
2. The tappets must be installed before the camshaft is installed. Lubricate and install the tappets into the valve guides.
3. Position the camshaft inside the block.

NOTE: *Align the marks on the camshaft and the automatic spark advance, if so equipped.*

4. Lubricate the rod and insert it into the bearing plate side of the block. Install one 0.005 in. washer between the end of the camshaft and the block. Push the rod through the camshaft and tap it lightly until the rod just starts to enter the bore at the PTO end of the block. Check the endplay and adjust it with additional washers if necessary. Press the rod into its final position.
5. The fit at the bearing plate for the cam-



Installing the camshaft



Timing marks for the automatic spark advance

shaft rod is a light to loose fit to allow oil that might leak past to drain back into the block.

CRANKSHAFT

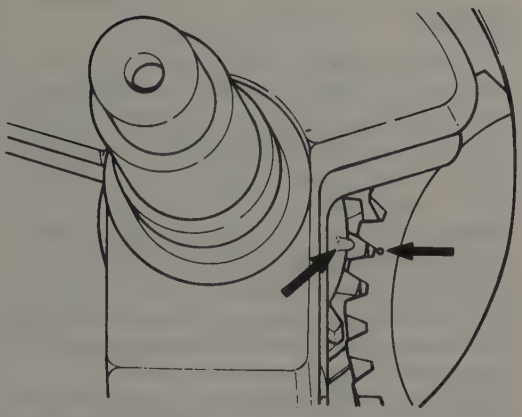
1. Place the block on the base of an arbor press and carefully insert the tapered end of the crankshaft through the inner race of the anti-friction bearing.
2. Turn the crankshaft and camshaft until the timing mark in the shoulder of the crankshaft lines up with the mark on the cam gear.
3. When the marks are aligned, press the crankshaft into the bearing, making sure that the gears mesh as it is being pressed in. Recheck the alignment of the timing marks on the crankshaft and the camshaft.
4. The end-play of the crankshaft is controlled by the application of various thickness gaskets between the bearing plate and the block. Normal end-play is achieved by installing 0.020 in. and 0.010 in. gaskets, with the thicker gaskets on the inside.

BEARING PLATE

1. Press the front main bearing into the bearing plate. Make sure that the bearing is straight.
2. Press the bearing plate onto the crankshaft and into position on the block. Install the cap screws and secure the plate to the block. Draw up evenly on the screws.
3. Measure the crankshaft end-play, which is very critical on gear reduction engines.

PISTON AND ROD ASSEMBLY

1. Lubricate the pin and assemble it to the connecting rod and piston. Install the wrist pin retaining ring. Use new retaining rings.
2. Lubricate the entire assembly, stagger the ring gaps and, using a ring compressor, slide the piston and rod assembly into the cylinder bore with the connecting rod marks on the flywheel side of the engine.
3. Place the block on its end and oil the connecting rod end and the crankpin.



Alignment of the timing marks for the crankshaft and the camshaft

4. Attach the rod cap, lock or lock washers, and the cap screws. Tighten the screws to the correct torque.

NOTE: *Align the marks on the cap and the connecting rod.*

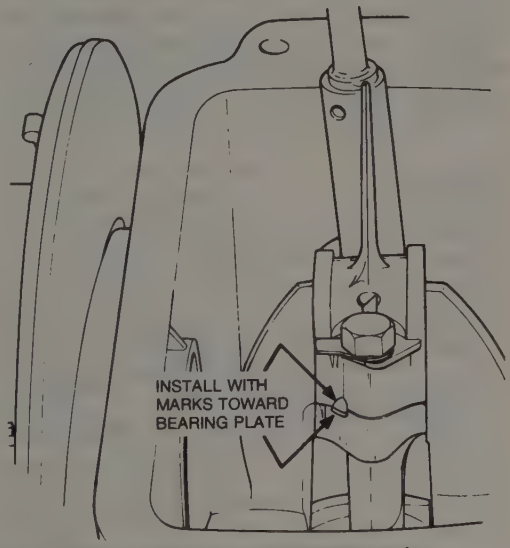
5. Bend the lock tabs to lock the screws.

CRANKSHAFT OIL SEALS

Apply a coat of grease to the lip and guide the oil seals onto the crankshaft. Make sure no foreign material gets onto the knife edges of seal, and make sure the seal does not bend. Place the block on its side and drive the seals squarely into the bearing plate and block.

OIL PAN BASE

Using a new gasket on the base, install pilot studs to align the cylinder block, gasket, and base. Tighten the four attaching screws to the correct torque.



Connecting rod and cap alignment marks

VALVES

1. See the engine rebuilding section of the "Clinton" chapter for details concerning installation of the seats and guides. Clean the valves, seats, and parts thoroughly. Grind and lap-in the valves and seats for proper seating. Valve seat width must be 1/32"–1/16". After grinding and lapping, slide the valves into position and check the clearance between stem and tappet. If the clearance is too small, grind the stem ends square and remove all burrs. On engines with adjustable valves, make the adjustment at this time.

2. Place the valve springs, retainers, and rotators under the valve guides. Lubricate the valve stems, and then install the valves down through the guides, compress the springs, and place the locking keys or pins in the grooves of the valve stems.

CYLINDER HEAD

1. Use a new cylinder head gasket.
2. Lubricate and tighten the head bolts evenly, and in sequence, to the proper torque.
3. Install the spark plug.

BREATHER ASSEMBLY

Assemble the breahter assembly, making sure that all parts are clean and the cover is securely tightened to prevent oil leakage.

MAGNETO

On flywheel magneto systems, the coil-core assembly is secured onto the bearing plate. On magneto-alternator systems, the coil is part of the stator assembly, which is secured to the bearing plate. On rotor type magneto systems, the rotor has a keyway and is press fitted onto the crankshaft. The magnet rotor is marked "engine-side" for proper assembly. Run all leads through the hole provided at the 11 o'clock position on the bearing plate.

FLYWHEEL

1. Place the washer in place on the crankshaft and place the flywheel in position. Install the key.
2. Install the starter pulley, lock washer, and retaining nut. Tighten the retaining nut to the specified torque.

BREAKER POINTS

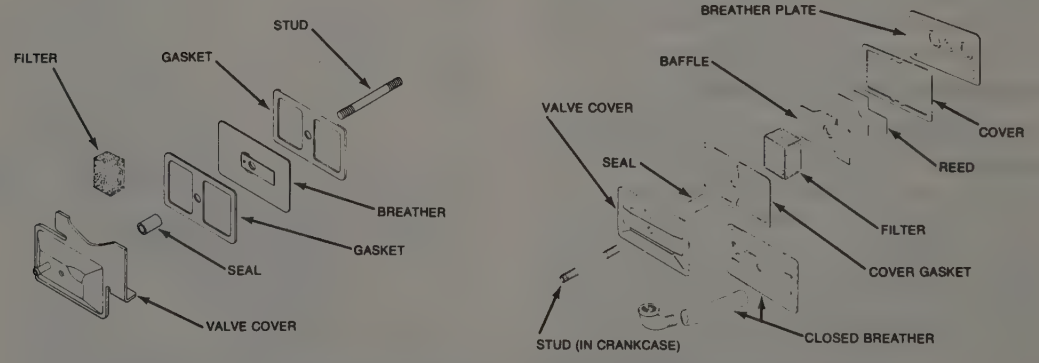
1. Install the pushrod.
2. Position the breaker points and fasten them with the two screws.
3. Place the cover gasket into position and attach the magneto lead.
4. Set the gap and install the cover.

CARBURETOR

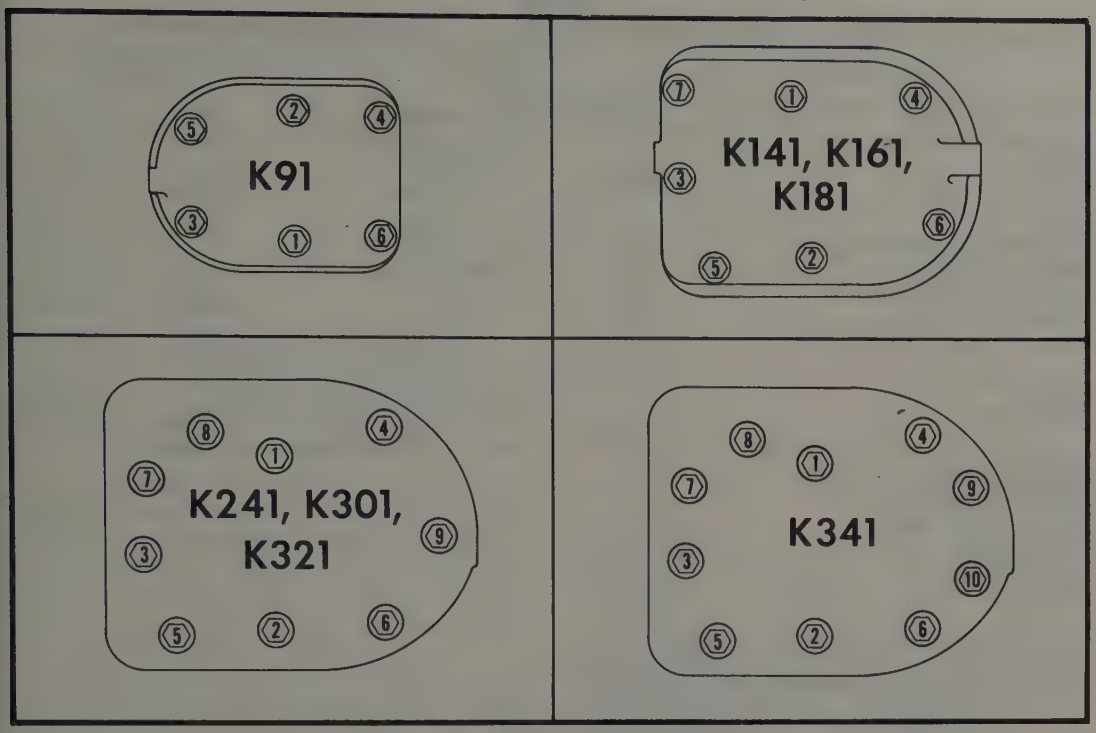
Insert a new gasket and assemble the carburetor to the intake port with the two attaching screws.

GOVERNOR ARM AND LINKAGE

1. Insert the carburetor linkage in the throttle arm.
2. Connect the governor arm to the carburetor linkage and slide the governor arm into the governor shaft.
3. Position the governor spring in the speed control disc.
4. Before tightening the clamp bolt, turn the shaft counterclockwise with pliers as far as it will go; pull the arm as far as it will go to the left (away from the carburetor), tighten the nut, and check for freedom of movement. Adjust the governor.



Exploded views of two common types of breathers showing assembly sequence



Cylinder head torquing sequences

BLOWER HOUSING AND FUEL TANK

Install the head baffle, cylinder baffle, and the blower housing, in that order. The smaller cap screws are used on the bottom of the crankcase. Install the fuel tank and connect the fuel line.

RUN-IN PROCEDURE

1. Fill the crankcase with a *non-detergent* oil and run it under load for 5 hours to break it in.
2. Drain oil and refill crankcase with the recommended detergent type oil. Nondetergent oil must not be used except for break-in.

Engine Rebuilding Specifications

Specification	K91
Displacement	
Cubic Inches	8.86
Cubic Centimeters	145.19
Horsepower (Max RPM)	4.0
Cylinder Bore	
New Diameter	2.375
Maximum Wear Diameter	2.378
Maximum Taper	.0025
Maximum out of Round	.005
Crankshaft	
End Play (Free)	.0228/.0038

Engine Rebuilding Specifications (cont.)

Specification	K91
Crankpin	
New Diameter	.936
Maximum Out of Round	.0005
Maximum Taper	.001
Camshaft	
Run Clearance on Pin	.001/.0025
End Play	.005/.020
Connecting Rod	
Big End Maximum Diameter	.9385
Rod-Crankpin Max Clear	.0035
Small (Pin) End-New Dia	.56315
Rod to Pin Clearance	.0007/.0008
Piston	
Thrust Face-Max Wear Dia*	2.359
Thrust Face*-Bore Clear	.0035/.006
Ring-Max Slide Clearance	.006
Ring-End Gap in New Bore	.007/.017
Ring-End Gap in Used Bore	.027
Valve-Intake	
Valve-Tappet Cold Clear	.005/.009
Valve Lift (Zero Lash)	.2095
Stem to Guide Max Wear Clear	.004
Valve-Exhaust	
Valve-Tappet Cold Clear	.011/.015
Valve Lift (Zero Lash)	.1828
Stem to Guide Max Wear Clear	.006

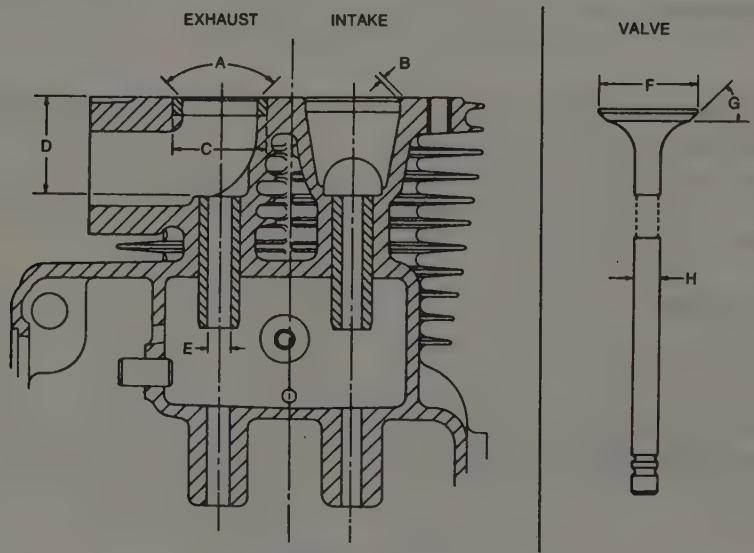
Engine Rebuilding Specifications (cont.)

Specification	K91
Tappet	
Clearance in Guide	.0005/.002
Ignition	
Spark Plug Gap-Gasoline	.025
Spark Plug Gap-Gas	.018
Spark Plug Gap (Shielded)	.020
Breaker Point Gap	.020
Trigger Air Gap (Breakerless)	NOT USED
SparkRun ° BTDC	20°
Spark Retard	NO RETARD
Torque Valves (Also See Pages 15.3)	
Spark Plug (foot lbs)	18–22
Cylinder Head	200 in. lbs
Connecting Rod	140 in. lbs
Flywheel Nut	40–50 ft lbs

*Measured just below oil ring and at right angles to piston pin

Valve Specifications

	Dimension	Model K91 Intake	Model K91 Exhaust
A	Seat Angle	89°	89°
B	Seat Width	.037/.045	.037/.045
C	Insert OD	—	.972/.973
D	Guide Depth	None	None
E	Guide ID	None	None
F	Valve Head Diameter	.979/.989	.807/.817
G	Valve Face Angle	45°	45°
H	Valve Stem Diameter	.2480/.2485	.2460/.2465



Key to valve specifications chart

8
Onan

This section pertains to the AJ series of industrial engines and the engines installed on AK series electric generating plants. Although the engines are not the same size in displacement, they are mechanically very similar. Please note that the procedures given here pertain directly to the AJ series industrial engines. They can be applied to the AK generating plant engines with a few very minor changes. Carburetor specifications for both engines are the same.

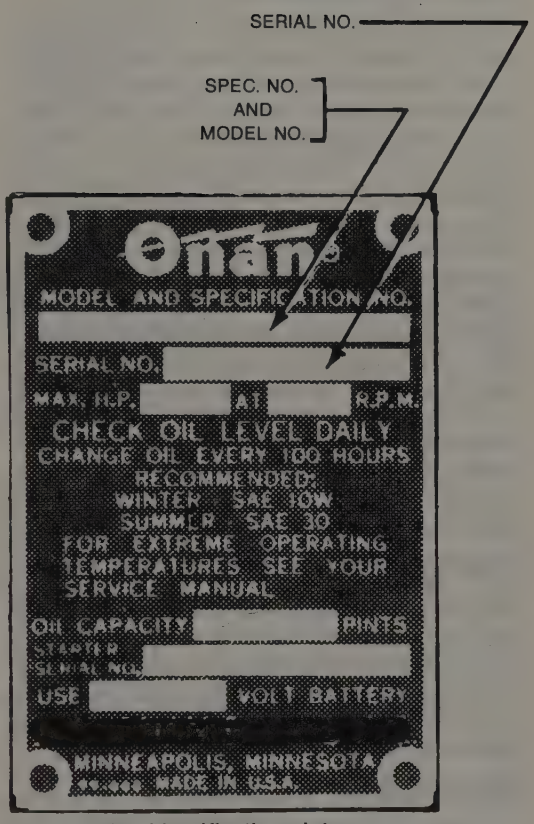
Setting the governor on the electrical generating plants is more critical than on the non-generator engines because the engine speed determines the power output of the generator.

At the end of the chapter, specifications for size, clearances, and torque for both engine series are given.

ENGINE IDENTIFICATION

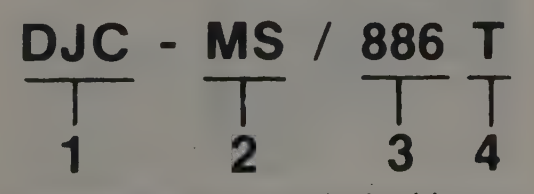
All Onan engines have an identification plate attached to the left side of the cooling shroud (facing the flywheel) on one cylinder engines, and on the right side of the cooling air duct (facing the flywheel) on four cylinder engines. The Model and Specification number shown there may be interpreted as follows:

1. Factory code for general engine identification.
2. Engine specific type:
   - S-Manual starting with stub shaft power take-off.
   - MS-Electric starting with stub shaft, starter, and generator.
   - MSV-Vacu-Flo cooling. Similar to MS, but with cooling air drawn in through a front end duct.
3. Factory code for optional equipment on the engine.
4. Specification letter. Letter advances alphabetically with production modifications.



Onan engine identification plate

Serial numbers consist of a two digit month of manufacture indicator and a six digit engine number.



Model and Specification Number breakdown

General Engine Specifications

Model	Bore & Stroke (in.)	Displacement (cu. in.)	Horsepower @ RPM
AK	2.5 × 2.5	12.3	3.7 @ 3600
AJ	2.75 × 2.5	14.9	5.5 @ 3600
LK	3.25 × 3.00	24.9	5.0 @ 1800

MAINTENANCE

Air Cleaner Service

OIL BATH AIR CLEANER

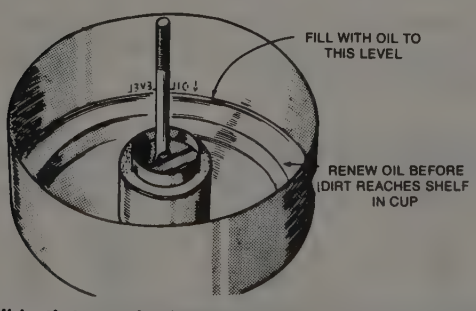
The oil bath air cleaner uses engine oil to collect dirt. Dirt is deposited in a sump full of oil in the bottom of the unit, and on a screen contained in the upper portion. Dirt sticks to the screen because the incoming air pulls some of the oil out of the sump, depoits it on the screen, and this wetting action keeps the screen sticky. After each 100 hours, diassemble the unit, drain the oil out of the sump, clean the dirt out of the sump with a solvent soaked rag, and refill the sump with clean oil of the type used in the engine. If the air around the engine is very dusty, inspect the air cleaner more frequently. Make sure to change the oil in the sump before dirt contained in the sump reaches the ring which is slightly above the bottom. In extreme cases, it may be necessary to clean the screen with solvent and coat it with clean oil as part of the service.

MOISTENED FOAM AIR CLEANER

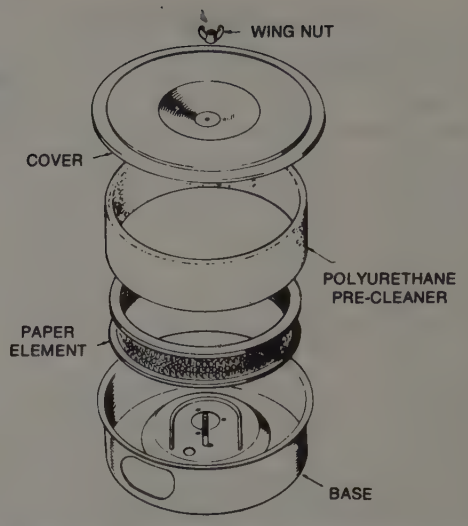
This cleaning medium in this type of cleaner is an oil soaked sponge mounted around a screen. After each 100 hours, wash the sponge in soap and water or solvent, dry it, soak it in engine oil, and then squeeze excess oil out of it before installation.

DRY PAPER AIR CLEANER

Dry paper air cleaners use a replaceable paper element. All that is required in servicing is



Oil bath type air cleaner



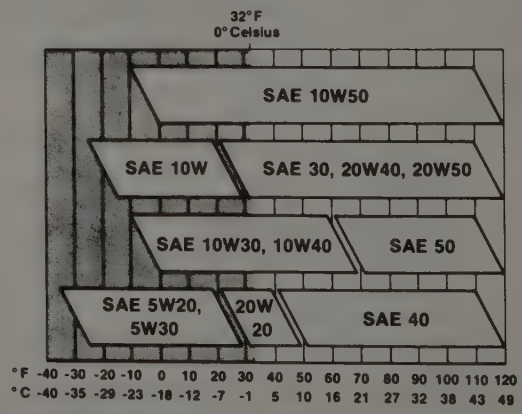
Dry paper air cleaner with polyurethane precleaner

disassembly of the unit, replacement of the element, and a brief removal of dust from inside the unit with a rag. Some of these units also employ a polyurethane precleaning element, which is also replaced at time of service, or a dust cup, which is cleaned with a solvent soaked rag and dried. Service standard units every 100 hours; units with precleaner at 500 hours.

Lubrication

OIL AND FUEL RECOMMENDATIONS

Onan gasoline engines may use either regular grade leaded, unleaded, or low lead gasoline. The use of unleaded or low lead fuels is strongly recommended in order to reduce combustion chamber deposits, especially on governor controlled engines which run at a fairly steady load. If you are switching from leaded to unleaded fuel, combustion chamber deposits should be removed before beginning



Oil viscosity chart

Crankcase Capacity Chart

AK	1.25
AJ	1.75*
LK	2.0

* Portable Model—1.25

operation on the unleaded fuel because of its lower octane rating and consequent potential for damage due to engine knock.

It is best to use an SE oil, although oils not so well equipped to resist sludge formation at both high and low temperatures may be used in very moderate service—i.e. long operating periods under light loads. Consult the chart for recommended viscosity ranges for the prevailing temperature.

TUNE-UP

Spark Plugs

Spark plug should be replaced every 200 operating hours. Set the gap with a wire gauge to .025 in. It is best to torque the plugs with a torque wrench to avoid cylinder head damage, distorted gap dimension, or leakage. Use new gaskets and torque to 25–30 ft. lbs. Plugs should also be inspected and cleaned with a wire brush once or twice, depending on type of fuel and service, during their service life. Use new plug gaskets even when reinstalling old plugs.

Breaker Points

Breaker points must be inspected and cleaned up and gapped or replaced as required. Gain access to the points as described below under "Ignition Timing." Inspect the points for burning and pitting. If only slightly worn or damaged, points may be dressed with an abrasive stone and regapped. Otherwise, they must be replaced.

To replace points, disconnect the primary electrical connection, remove the mounting screws and remove the old set. Install the new set with mounting screws slightly loose. Turn the engine over slowly until points reach their maximum gap. Then, using a flat feeler gauge of proper dimension (see the tune-up chart), shift the contact set base plate as necessary, or adjust the Allen screw, to get the proper gap, tighten the mounting screw, and recheck. In some cases, a slight further adjustment may be needed to get the proper timing. Make sure to lube the cam follower with high temperature grease or oil, as necessary, when replacing or servicing points.

Tune-Up Specifications

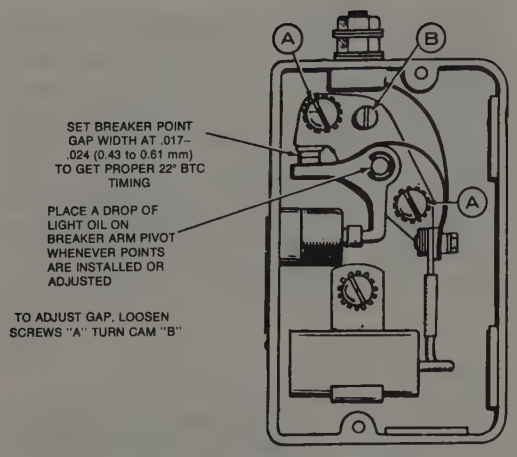
Model	Spark Plug Gap (in.)	Ignition Point Gap (in.)	Ignition Timing (Deg. BTDC @ RPM)
AJ	.025	.022	19 @ 1800, 25 @ 3600
AK	.025	.022	19 @ 1800, 25 @ 3600
LK	.025	.020	19

Ignition Timing

1. Gain access to the points as follows:
   a. Remove the air housings and blower wheel on Vacu-Flo units, or just the blower housings on pressure-cooled units.
   b. Loosen the flywheel bolt a few turns, and then, while prying outward on the flywheel, tap the flywheel bolt with a hammer.
   c. Remove the breaker cover screw and remove the breaker cover.
2. Set the point gap as described above.
3. Crank the engine slowly by hand in a forward direction until the painted mark on the flywheel and the TC mark on the gear cover are aligned. The engine must be on the compression stroke; otherwise, turn it one more revolution.
4. Turn the flywheel slowly and note whether the timing marks are aligned just as the points break. If not, loosen the breaker box mounting screws and shift the breaker box assembly slightly upward if points open too soon, or downward if they open too late. Tighten the breaker box mounting screws.
5. Check the timing with an automotive timing light or with a test lamp run from the primary connection on the breaker box to a good ground on the engine. To check the timing with a test lamp, turn the engine backwards and then slowly approach the point where the timing marks align. The light should go out just as the timing marks align.

AJ ENGINES WITH BATTERY IGNITION

1. Timing can be checked either at the timing hole on the front of the blower housing or at a hole on the side of the blower housing. Turn the engine over until it passes the 22 degrees BTDC timing mark so the points will be wide open.
2. Remove the cover on the breaker box and set point gap to .020 in. with a flat feeler gauge. Then, install the breaker box cover and check the timing with a timing light while the engine is running.
3. If timing is not correct, reduce point gap


A
B
SET BREAKER POINT GAP WIDTH AT .017–.024 (0.43 to 0.61 mm) TO GET PROPER 22° BTC TIMING
PLACE A DROP OF LIGHT OIL ON BREAKER ARM PIVOT WHENEVER POINTS ARE INSTALLED OR ADJUSTED
TO ADJUST GAP, LOOSEN SCREWS "A" TURN CAM "B"

Setting point gap and timing on battery ignition AJ engines

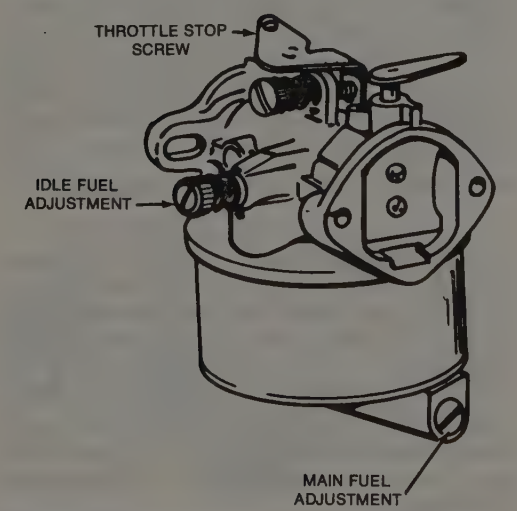
to make timing later, or increase it to advance timing. Gap may fall anywhere in the range .017–.024 in. to get correct timing.

4. Repeat the procedure until timing is correct.

Mixture Adjustments

Factory mixture adjustments should not be disturbed unless the engine clearly is running too rich or too lean. Standard settings are: Main Jet—1¼ turns open; Idle Jet—1 turn open. Do not force the needle against the seat by turning it in hard when making these settings. Turn the screw in slowly until it just bottoms very gently, then turn it out the specified amount.

If it is necessary to adjust further, run the engine until it is hot and remove all load. Run the engine at idle speed and adjust the idle mixture screw in and out slowly until highest speed and smoothest running are obtained. Adjust the man jet mixture screw similarly, with the engine running at normal speed without load. Test the response of the engine when accelerating from idle and open the main jet ¼ turn more if acceeleration response is poor. If the governor "hunts" open and closed, the main jet may be opened as ¼ turn more or ½ turn beyond point of highest operating speed without load.



Locations of idle and main fuel mixture screws

Governor Adjustments

Run the engine or engine/generator under light load until it is hot. On generator sets, engine rpm controls both output frequency and voltage, so both speed and sensitivity settings are critical. Use of an accurate tachometer is the best mean of getting good performance without overspeeding the engine.

AK, AJ GENERATORS

Engine speed at full load should be 1,800 rpm for four pole generators; 3,600 rpm for two pole generators. These speeds should increase to 1,900 rpm an 3,800 rpm at no load, respectively. On these generators, if speed droop or change in speed is too great, turn the sensitivity adjusting screw outward, then recheck full load speed and adjust as necessary with the speed adjusting nut, turning it clockwise to increase speed. Repeat both adjustments as necessary until full load and no load speeds are both correct. If the unit hunts constantly by opening and closing the throttle in a regular rhythm, decrease sensitivity slightly and then readjust the speed setting.

LK ENGINES

First adjust the speed adjusting nut (clockwise to increase) to the setting called for on the nameplate. If the voltage drop with increase in load is too great, loosen the locknut and turn the sensitivity adjusting screw inward, or toward the shaft, retighten the locknut, and recheck speed. Repeat adjustments as necessary.

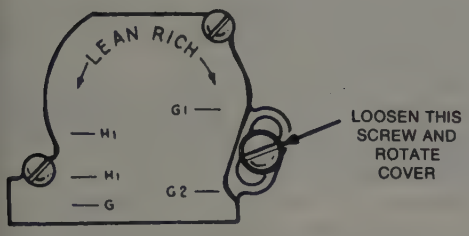
Automatic Choke Adjustment

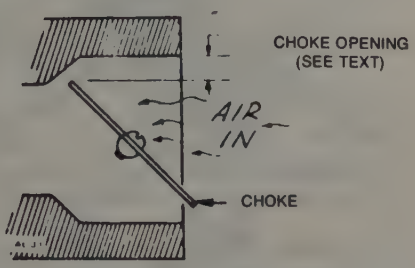
AK, AJ, LK

1. Loosen the choke cover screws (2) and rotate the cover as necessary to get the following dimension between the inner edge of the choke plate and the wall of the carburetor air horn: At 58°F—¼ in. open; at 66°F—½ in. open; at 76°F—¾ in. open; at 82°F—fully open.

2. Tighten the choke cover screws.

AMBIENT TEMP. (°F)	60	65	70	75	80	85	90	95	100
CHOKE OPENING (Inches)	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4





Thermal-magnetic choke adjustment specifications

Valve Adjustment

Adjust the valve clearance with the engine cold and in TDC position with the spark plug about to fire. Adjustment is checked by sliding a flat feeler gauge of the proper dimension (see specifications, noting that clearances are different for exhaust and intake valves) between the tappet and head of the valve stem. If necessary, turn the adjusting nut on the tappet while holding tappet with a second wrench to get a slight pull on the gauge.

Testing Compression

1. Run the engine until hot. Stop and remove spark plugs.
2. Insert the compression gauge in one of the spark plug holes and crank the engine with the starter. Record the reading.
3. Squirt a small amount of SAE 30 oil into the cylinder and repeat the check.
4. Repeat steps 2 and 3 for each cylinder. Compression specifications are listed below. If compression is low, but increases substantially when oil is squirted into the cylinder, the compression problem is probably with the pistons, rings, and cylinders. Compression pressures are: (psi)
   - AK, AJ—95–105
   - LE—90–110

FUEL SYSTEM

Carburetion

The carburetor is a side draft or horizontal float type with two adjusting screws for the idle needle and the main fuel nozzle needle.

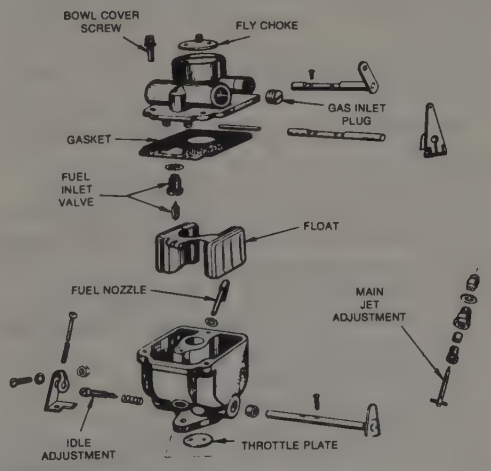
BASIC DOWNDRAFT AND SIDEDRAFT CARBURETORS

Removal and Installation

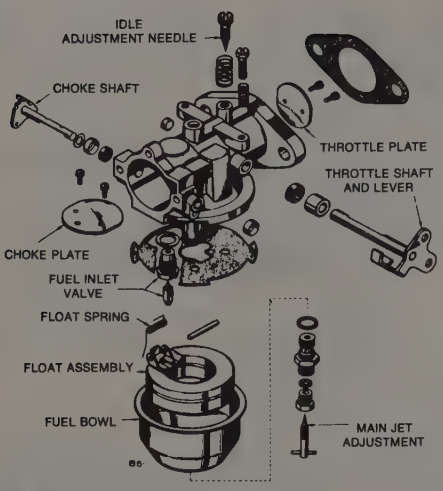
1. Remove air cleaner, fuel line, governor linkage and choke apparatus from carburetor.
2. Remove two carburetor mounting nuts and pull off carburetor. On CC Engines, first remove the intake manifold; then remove the carburetor from the manifold.
3. Reverse above steps to install carburetor on engine.

Overhaul

1. Remove air cleaner adapter and choke from carburetor.
2. Remove main fuel adjustment needle and needle retainer.
3. Remove top of carburetor from carburetor base.
4. Remove carburetor float, lift out float valve and unscrew and remove its seat.
5. Remove no load adjusting needle.
6. Remove throttle plate and throttle shaft.
7. Remove choke plate and choke shaft.
8. Remove nozzle assembly.
9. Soak all components thoroughly in carburetor cleaner, following cleaner manufacturer's instructions. Clean all carbon from carburetor bore, especially in the area of the throttle valve. Blow out passages with com-



Exploded view of downdraft carburetor



Exploded view of sidedraft carburetor

pressed air. Avoid using wire to clean out passages.

10. Check adjusting needles and nozzle for damage. If the float is loaded with fuel or damaged, replace it. The float should turn freely on its pin without binding. Invert the carburetor body and measure float level.

11. To adjust float level, bend small lip that needle valve rides on.

12. Check choke and throttle shafts for excessive side play and replace if necessary.

13. Install throttle shaft and valve, using new screws. The bevel on the throttle plate must fit flush with carburetor body. On valve plates marked with a "C," install them with the mark on the side toward idle port as viewed from flange end of carburetor. To center throttle valve (Bendix/Zenith Carburetor) back off stop screw, close throttle lever, and seat valve by tapping it with a small screwdriver, then tighten the two throttle plate screws.

14. Install choke shaft and choke plate. Center choke plate in same manner as throttle valve. Always fasten plate in position with new screws.

15. Install main nozzle. Make sure it seats in body casting.

16. Install main fuel adjustment needle and its retainer.

17. Install no load adjusting needle.

18. Install intake valve seat and intake valve.

19. Install float and float pin. Center pin so float bowl doesn't ride against it.

20. Check float level. Adjust if necessary.

21. Install a new body-to-bowl gasket and secure the two sections together.

22. Reinstall choke.

23. Install air horn assembly.

24. Install carburetor on engine.

25. Adjust both main and idle fuel mixture needles, as described in the Tune-Up section.

Mechanical Fuel Pumps

REMOVAL AND INSTALLATION

1. Remove the fuel lines.

2. Remove the two mounting capscrews, and pull the pump off the engine. Remove and discard the gasket.

3. Clean all gasket material from both mounting pad and pump flange. Apply an oil resistant sealer to both sides of a new gasket and to the threads of the attaching bolts.

4. Position the new gasket on the pump flange and position the pump and gasket on the mounting pad. To check their position, make sure the rocker arm rides on the pump cam lobe. Turn the crankshaft until the rocker arm is at the low point of its stroke.

5. Position the pump tightly against the pad and install the mounting bolts, torquing them alternately in several stages to specifications.

6. Connect the fuel lines and then operate the unit to check for leaks.

SERVICE

1. Scribe a mark across the flanges of the pump body and valve housing so these parts can be assembled in original positions.

2. Remove the valve housing from the body of the pump. Tap pump body with a screwdriver to do this.

3. Remove both valves and their gaskets from valve housing. Note position of valves in their housing so new valves can be correctly installed.

4. Using a blunt punch, drive rocker arm pin out of pump.

5. Press diaphragm into fuel pump body and then pull rocker arm outward to unhook diaphragm actuating rod from rocker arm link assembly.

6. Remove diaphragm and diaphragm return spring, rocker arm and link assembly, and rocker arm return spring from pump body.

7. Remove diaphragm actuating rod oil seal from pump body.

8. Clean and inspect all fuel pump components and replace all unserviceable parts.

9. Install inlet and outlet valves and their gaskets in their respective positions. Seat valves firmly.

10. Lubricate diaphragm actuating rod.

11. Position fuel pump diaphragm and spring assembly into pump body as shown.

12. Hold diaphragm assembly in pump body and position pump body so mounting flanges faces up. Apply slightly more pressure to lower edge of diaphragm and insert rocker arm link assembly.

13. Hook rocker arm link to diaphragm actuating rod.

14. Install rocker arm return spring and hold it in place by cocking rocker arm slightly.

15. Install the rocker arm pin in the pump body.

16. Position the valve body and pump body so the two previously scribed marks align. Install all screws and lockwashers until they just engage the pump body, being careful not to tear the diaphragm fabric.

17. Alternately and evenly tighten all screws.

Bendix Electric Fuel Pumps

SERVICE

1. Release the bottom cover (1) from the bayonet fittings. Twist the cover by hand to remove it from the pump body.

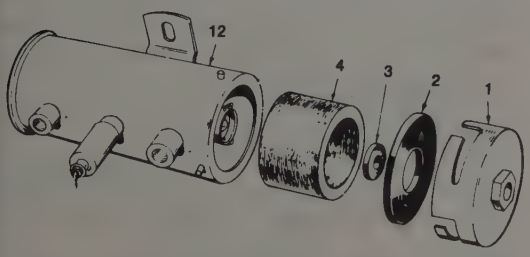
2. Remove the filter (4), magnet (3) and cover gasket (2) (see appropriate illustration). Wash the filter in cleaning solvent and blow out dirt and cleaning solvent with air pressure. Check the cover gasket and replace if deteriorated. Clean the cover.

3. Remove the retainer spring (5) from plunger tube (11), using thin nose pliers to spread and remove the ends of the retainer from the tube. Then remove the washer (6), O—ring seal (7), cup valve (8), plunger spring (9) and plunger (10) from the tube (11), (see appropriate illustration).

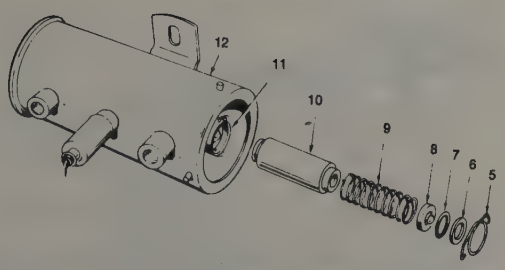
4. Wash all parts in cleaning solvent and blow out with air pressure. If the plunger does not wash clean or if there are any rough spots, gently clean the surface with a crocus cloth. Slosh the pump assembly in cleaning solvent. Blow out the tube with air pressure. Swab the inside of the tube with a cloth wrapped around a stick.

5. Insert the plunger assembly (10) in the tube with the buffer spring end first. Check the fit by slowly raising and lowering the plunger in the tube. It should move fully without any tendency to stick. If a click cannot be heard, the interrupter assembly is not functioning properly in which case pump should be replaced.

6. To complete the assembly, install the



Bendix electric fuel pump—removal of bottom cover, gasket, magnet, and filter



Bendix electric fule pump—removal of retainer, O-ring, cup valve, spring, and plunger

plunger spring (9), cup calve (8), O—ring seal (7) and washer (6) as shown. Compress the spring (9) and assemble the retainer (5) with ends of the retainer in the side holes of tube (11).

7. Place the cover gasket (2) and magnet (3) in the bottom cover (1) and assemble the filter (4) and cover assembly. Twist the cover by hand to hold it in position on the pump housing. Securely tighten the bottom cover.

Onan Electric Fuel Pump

SERVICE

Clean the filters every 100 operating hours. Remove the four phillips screws from the top, and lift off the filter assembly. Clean the two screen-type filters in a safe solvent. Install, ensuring the gasket is in the proper position to prevent leaks.

Governor Repair

1. Draw a sketch of the governor linkage or lay the parts out in position as you disassemble them. Disassemble the linkage. Remove the gear cover.

2. Remove the snap ring that holds the governor cup to the camshaft gear, being ready to catch the flyballs, which will come out as the governor cup is removed.

3. Clean all parts thoroughly in a safe solvent. Inspect as follows and replace parts which are found defective:

a. flyballs for grooves or flat spots.

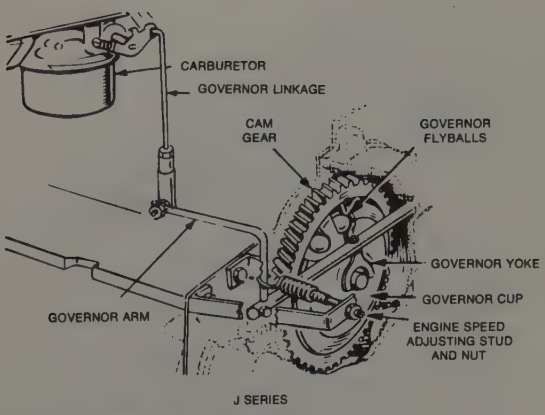
b. ball spacers for arms with noticeable wear or damage.

c. governor cup with a rough or grooved race surface.

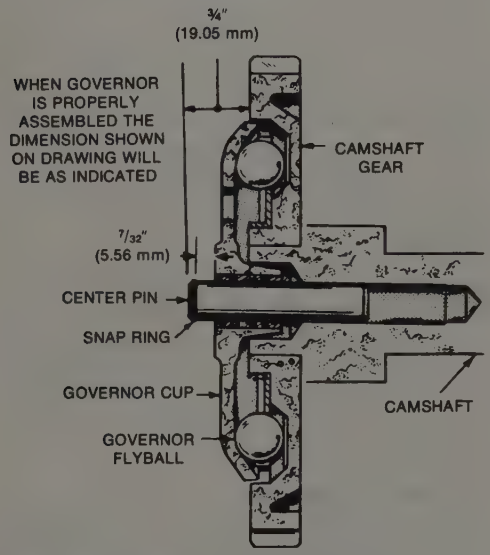
d. governor cup which does not have a free spinning fit on the camshaft center pin, or which is loose and wobbles.

4. To install the governor cup, tilt the engine to make the gear face upward. Space the flyballs at equal distances on the gear and then install the cup and snap ring on the camshaft center pin.

5. On J series this dimension should be $^{25}/_{32}$



Typical centrifugal type governor



Measuring governor in and out travel

in. Hold the cup against the flyballs to make this measurement. If the distance is not correct, pull out the center pin and replace it, pressing the new pin in just the required amount. If the pin extension is o.k., grind off the hub of the cup as required. In and out travel distance must be 7/32 in. or the engine will race.

ENGINE OVERHAUL

Valves

SERVICE

In order to remove the valves, the cylinder head must be removed. Remove the cylinder head screws and then remove the head from the engine. If the head sticks to the block, hit it lightly with a soft hammer, being careful not to damage any of the cooling fins. Remove the cylinder head gasket and discard it.

Use a conventional type valve spring compressor to compress the valve springs so that the spring retainer can be removed. The retainers are the split, tapered type and will most likely fall out when the valve spring is compressed. After removing the retainers, lift the valve out through the top of the valve guide. Clean the valves of all carbon deposits and inspect them, looking for warpage, worn stems, and burned surfaces that are partially destroyed. Determine whether or not the valve can be reused, whether it can be reground, or if the valve has to be replaced.

Check out the valve stem-to-guide clearance and, if it is too large, the guides must be replaced. They can be removed through the valve chamber. The valve tappets are also replaceable from inside the valve chamber, once the valves have been removed.

In removing the valve guides, first wire brush carbon and other deposits from the top guide surfaces, or the guide bores may be damaged during guide removal. Note that a gasket must be used on the intake valve guides for the LK, engines. Where used, place the gasket on the intake guide and install the intake and exhaust guides from within the valve chamber. Before installing the guides, run a small polishing rod with a crocus cloth through the guide holes to clean out deposits.

VALVE SEAT INSERT REMOVAL AND INSTALLATION

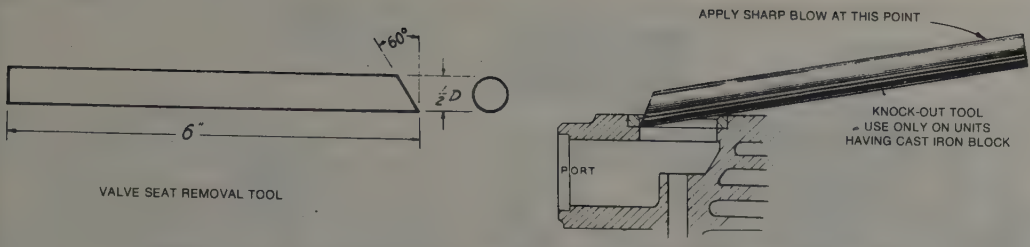
Use a solvent to clean carbon or stuck gasket material from cylinder head and block surfaces. If necessary, follow up using a metal scraper. Inspect the head gasket surfaces for cracks, nicks, or burrs. Check the head for cracks, and replace if any are present. An oil stone may be used to remove burrs or nicks.

Use a straightedge at three angles to check the head for flatness. Try to insert a .003 in. flat feeler gauge under the straightedge at any point, and replace the head if it is not flat.

Replace the valve seats if cracked or loose, or excessively worn. On cast iron engines, the seat may be driven out using a knockout tool as shown. The tool must be inserted under the port side of the valve seat with the square end extending over the cylinder bore. With the sharp edge of the tool at the joint between the seat and its recess, strike a sharp blow on the end of the tool with a light hammer. This will crack the insert and permit removal.

CAUTION: *Since this may shatter the relatively brittle material of the seat, you should wear goggles when performing the procedure.*

If the engine has an aluminum block, use a ¾ in. or one inch pipe tap to suit the seat di-



Special tool for removing valve seats from engines with cast iron blocks

ameter. Place a washer on top of the valve guide for the tap to bottom against. Turn the tap in until the seat begins to turn. As it starts to turn, begin pulling outward on the tap while continuing the turning motion to pull out the seat. Make sure the valve guide is not pushed downward by the tap or, if it is, that it is pressed back into position. Use an oversize replacement seat on aluminum engines.

Clean any carbon or burrs from the insert recess, and install a new seat as follows:

1. Gradually heat the block to 325 degrees F. Place the new seat in dry ice until thoroughly chilled.
2. Insert the pilot of an appropriate special tool in the valve guide hole in the block and quickly and evenly drive in the seat insert. It must seat on the bottom of the recess.

The valve face angle is 44°. The valve seat angle is 45°. The 1° interference angle assures a sharp seating surface between the valve and the seat and good sealing characteristics. The valve seat width must be between 1/32 in. and 3/64 in. Valves should not be hand lapped if at all possible. This is especially important if stellite valves are used.

To check the valves for a tight seal, make pencil marks around the valve face, then install the valve and rotate it a part of a turn. If the marks are all rubbed off uniformly, then the seal is good.

1. Insert the tappets in the crankcase holes.
2. Install the valves, springs and guides.
3. Using a valve spring compressor, compress each valve spring and insert the valve spring retainer and retainer locks.
4. Set the valve clearance to the specifications listed at the back of the chapter.
5. Install the heads and gaskets to the cylinder block.
6. Tighten the head bolts to the correct torque following the sequence in the appropriate illustration.
7. Install the exhaust manifold, oil lines, spark plugs and carburetor.

Cylinder head torque sequences

Gear Cover

REMOVAL AND INSTALLATION

In order to gain access to the camshaft gear and other internal components of the engine, it is necessary to remove the gear cover. In order to remove the gear cover, the magneto assembly must be removed. Disconnect the spark plug wire at the spark plug and disconnect the stop wire. Remove the attaching screws that hold the magneto assembly to the gear cover and remove the magneto.

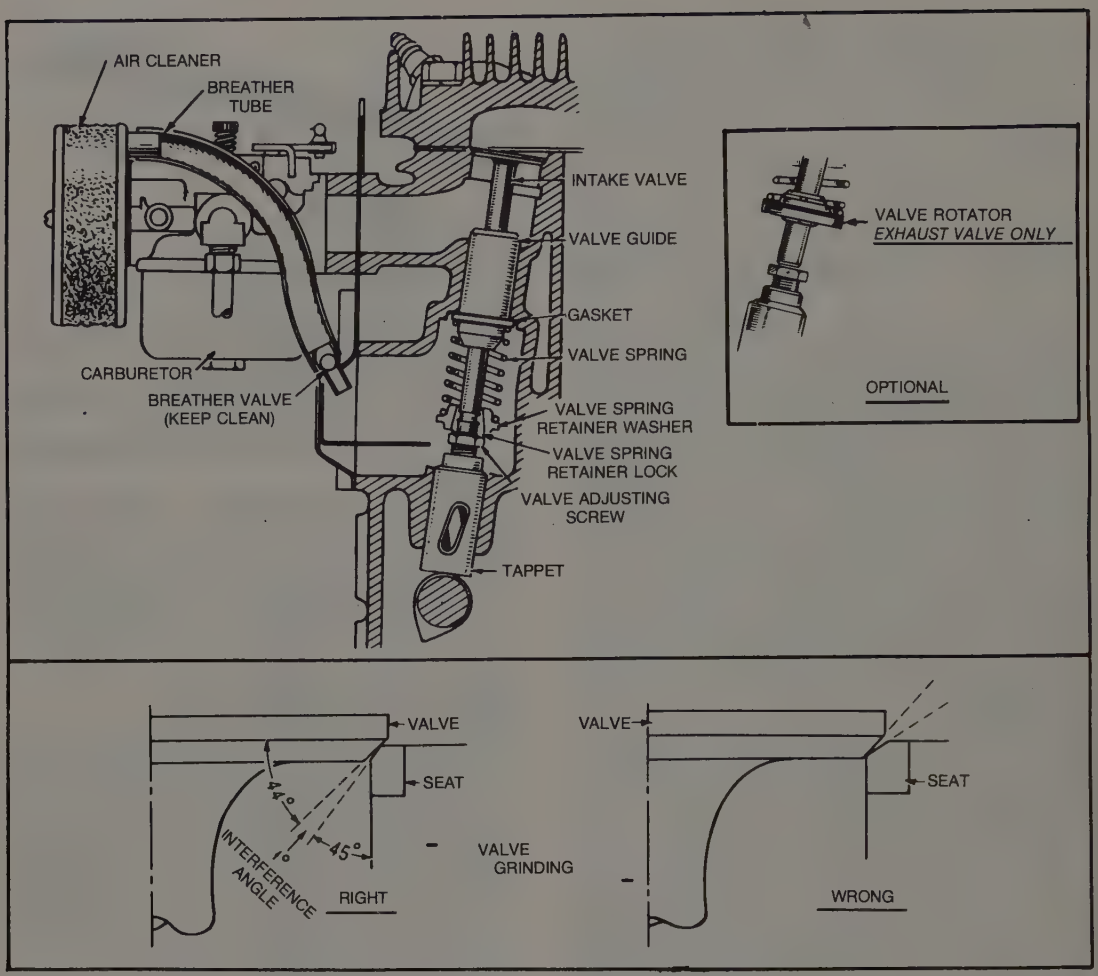
When the gear cover is removed, the governor shaft disengages from the governor cup, which is part of the camshaft.

During the installation of the cover, be sure to engage the pin on the cover, with the chamfered hole located in the governor cup. To do this, turn the governor cup so that the hole is located at the top or in the 12 o'clock position. Turn the governor shaft clockwise as far as it will go and hold it there until the cover is installed. Position the cover on the engine and make sure that it fits flush against the engine. Be careful of the gear cover oil seal during installation. Use a new gasket if the old one is damaged.

Timing Gears

REMOVAL AND INSTALLATION

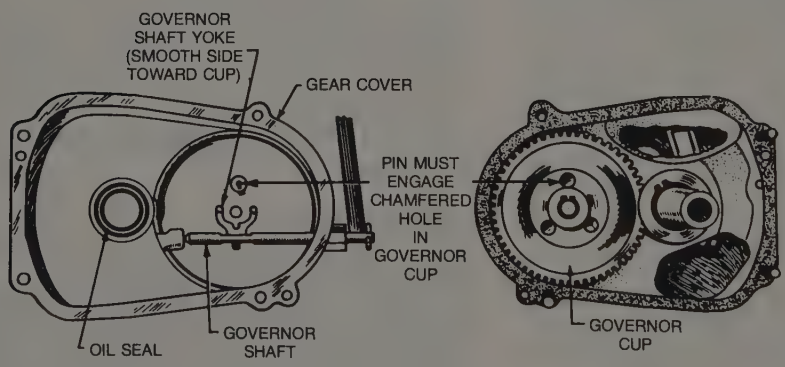
If it becomes necessary to replace either the crankshaft or camshaft gears because of broken teeth, extreme wear, cracks, etc., both gears must be replaced as a pair. Never replace only one of the gears. Both gears are pressed onto their respective shafts.

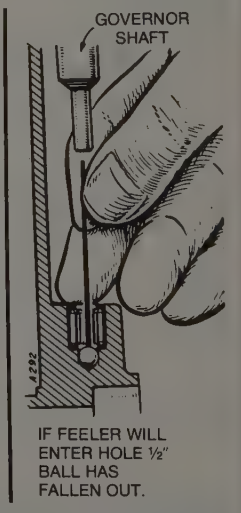


Valve and crankcase breather assembly

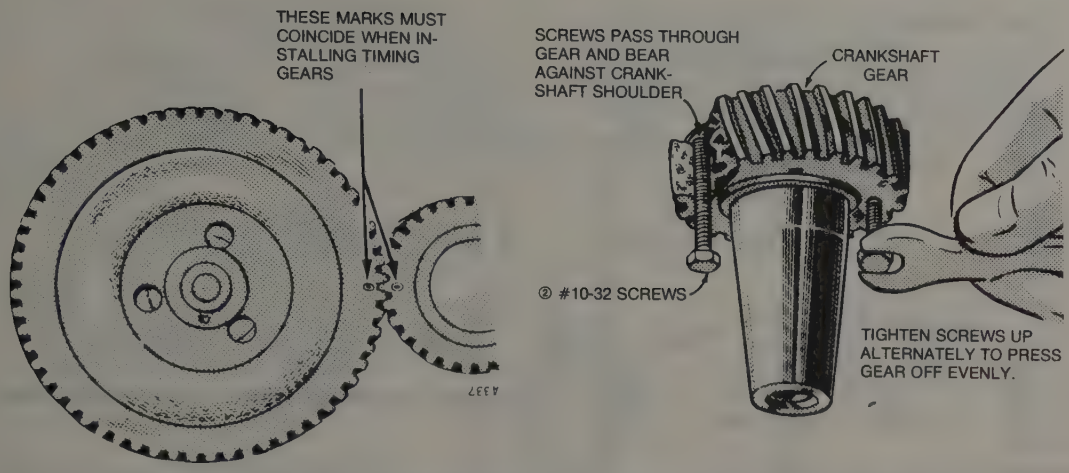
To remove the crankshaft gear, insert two #10-32 screws into the threaded holes in the gear and tighten the screws alternately a little at a time. The screws will press up against the crankshaft shoulder and force the gear off the end of the crankshaft. On AK engines use a gear puller to remove the crankshaft gear.

To remove the camshaft gear, it is necessary





Gear cover assembly


THESE MARKS MUST COINCIDE WHEN INSTALLING TIMING GEARS
SCREWS PASS THROUGH GEAR AND BEAR AGAINST CRANKSHAFT SHOULDER
CRANKSHAFT GEAR
② #10-32 SCREWS
TIGHTEN SCREWS UP ALTERNATELY TO PRESS GEAR OFF EVENLY.

Aligning the timing marks on the timing gears and removing the crankshaft gear

to remove the entire camshaft assembly from the engine. First remove the crankshaft gear lock ring and washer. Remove the cylinder head, valve assemblies, fuel pump (if so equipped), and the valve tappets. Remove the governor cup assembly and then remove the camshaft and gear assembly from the engine. The camshaft gear may now be pressed off the camshaft. Do not press on the camshaft center pin as it will be damaged. The governor ball spacer is press fit into the camshaft gear.

When the camshaft gear is replaced on the camshaft, be certain that the gear is properly aligned and the key properly positioned before beginning to press the gear onto the camshaft.

Install the governor cup before replacing the camshaft and gear assembly back into position in the engine.

There are two stamped 'O' marks, one on each gear, near the gear teeth. When the crankshaft and camshaft gears are meshed, these marks must be exactly opposite each other. When installing the camshaft gear assembly, be sure that the thrust washer that goes behind the camshaft gear is installed. Replace the retaining washer and lockwasher on the crankshaft.

Cylinder Bore, Piston, and Piston Rings

The cylinder can be rebored if it becomes heavily scored or badly worn. If the cylinder bore becomes cracked, replace the cylinder block.

The cylinder can be bored out to 0.010 in., 0.020 in., or 0.030 in. oversize.

NOTE: *The cylinder bore on the AK engine can be bored out to 0.040 in. oversize.*

There are pistons and rings in the above oversizes available to accommodate an oversized cylinder bore. If the cylinder bore has to be bored out only 0.005 in. to remove the damage in the cylinder, use standard size parts.

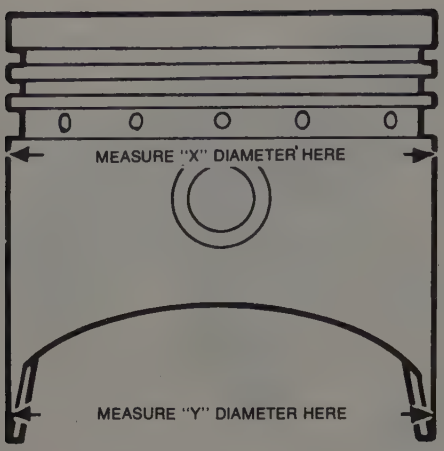
Use a ridge reamer to remove the ridge that may be present at the top of the cylinder bore to avoid damaging the piston rings when the piston and connecting rod assembly is removed. Hone the cylinder and create a cross hatch pattern on the cylinder walls if new rings are being installed. Clean the cylinder with SAE 10 engine oil after honing.

Some engines were originally built with 0.005 in. oversize pistons and are so indicated by a letter 'E' following the serial number stamped on the identification plate and on the side of the crankcase.

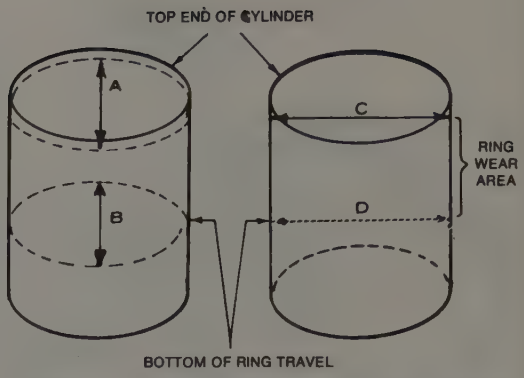
The piston is fitted with two compression rings and one oil control ring. When the piston assembly is removed from the engine, clean off all carbon deposits and open all of the oil return holes in the lower ring groove. Before installing new rings, check the ring gap by installing the rings squarely in the cylinder bore and measuring the gap between the two ends of the rings. If the gap is too small, it is possible to file the ends to obtain the proper size gap.

Tapered type rings are usually marked with the word 'TOP' on one side. This side must be installed facing toward the top or closed end of the piston. Position the ring gaps evenly around the circumference of the piston with no ring gap over the piston pin.

The piston pin is held in place by two lock rings, one at each end. Make sure that the lock rings are properly installed before installing the piston assembly in the cylinder. Be sure to check the size of the piston, piston pin, piston pin bore, and the size of the cylinder before



Measure piston at points shown



Locations for taking cylinder wear measurements

installing any of these parts back into the engine. Replace any parts that are worn beyond the maximum allowed specification. The piston should be replaced when the side clearance of the top ring reaches .008 in., or if there are signs of scuffing, scoring, worn ring lands, fractures, or preignition damage. Measure the piston dimensions at points shown in the illustration.

In fitting rings, install each ring in the cylinder bore, invert the piston and push the ring to the end of the ring travel—about halfway to the end of the bore. With the ring at exactly 90 degrees to the centerline of the bore, measure the end gap with a feeler gauge. Fit rings by choosing the right size for the bore—do not file the ends.

Connecting Rod

Before removing the connecting rod from the crankshaft, mark the cap and rod so they can be installed in exactly the same position from which they are removed.

If abnormal bearing wear (worn on one side more than the other) is noticed, this would indicate that the connecting rod is bent. It is possible to have the connecting rod straightened, but this should be done at a machine shop or small engine service shop.

Measure all of the bearing surfaces for size, including the piston pin hole and the crankpin bearing. Inspect the bearings for burrs, breaks, pitting and wear. Replace if scored or if the overlay is wiped out. Scratching is also reason for replacement. If bearings look all right, check bearing clearances. Place a piece of Plastigage of the proper width in the bearing cap about ¼ in. off center. Rotate the crankshaft about 30 degrees from bottom center, and install the bearing cap. Torque to specification. Without turning the crankshaft, remove the bearing cap, leaving the flattened Plastigage on the bearing or journal. Compare its widest point with the scale on the Plastigage envelope to determine clearance. If clearance is excessive, replace the connecting rod bearings.

Use a new piston pin to check the pin bushing for wear. A push fit clearance is required. If a new pin will fall through a dry rod bore of its own weight, replace the rod bushing.

To replace the bushings, press them out using a press and proper driving tool. Press in the new bushings so that the ends are flush with the sides of the rod and a 1/16 in. oil groove is formed in the center. If there are oil holes, make sure they are at least half way open. Make sure the pin is a push fit after the bushing is installed.

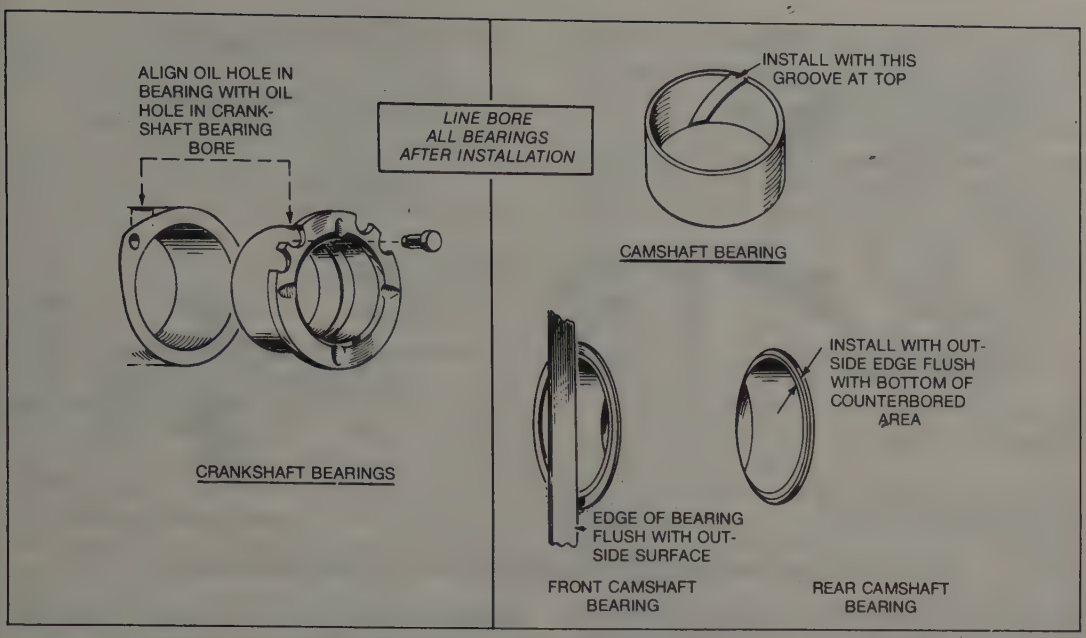
Replace rod nuts or bolts if the threads are damaged. Replace rods which are nicked or fractured, or which have bores which are out of round more than .002 in. Straighten or replace rods which are twisted more than .012 in. or out of line more than .005 in.

Be sure to reinstall the oil dipper to the connecting rod cap when assembling the piston and connecting rod assembly to the crankshaft.

Cylinder Block

INSPECTION

Check the entire block thoroughly for cracks, and check the cylinder bore for scoring. Measure the bores for out-of-round at points indicated. A is the point where greatest ring wear occurs, and B is the bottom of ring travel. C and D are at the same heights as A and B respectively, but at 90 degrees. Compare (subtract the smaller from the larger) A and B and then compare C and D to determine taper. Cylinder must be rebored for the next oversize piston if taper exceeds .005 in. Comparing A to C and B to D indicates out-of-round.


ALIGN OIL HOLE IN BEARING WITH OIL HOLE IN CRANK-SHAFT BEARING BORE
LINE BORE ALL BEARINGS AFTER INSTALLATION
INSTALL WITH THIS GROOVE AT TOP
CAMSHAFT BEARING
CRANKSHAFT BEARINGS
INSTALL WITH OUT-SIDE EDGE FLUSH WITH BOTTOM OF COUNTERBORED AREA
EDGE OF BEARING FLUSH WITH OUT-SIDE SURFACE
FRONT CAMSHAFT BEARING
REAR CAMSHAFT BEARING

Crankshaft main bearings and camshaft bearings for the AJ series engines

If the cylinder is out-of-round .002 in., it must be rebored for the next oversize piston.

HONING CYLINDERS TO OVERSIZE DIMENSIONS

1. Anchor the block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at about 250 to 450 rpm.

2. Lower the hone into the cylinder until it protrudes ½ to ¾ inch past the end of the cylinder. Rotate the adjusting nut until the stones just come in contact with the cylinder wall at its narrowest point.

3. Loosen the adjusting nut until the hone can be turned by hand.

4. Connect the drill to the one and start the drill. Move the hone up and down in the cylinder about 40 times per minute. Usually the bottom of the cylinder must be worked out first because it is smaller. When the cylinder takes a uniform diameter, move the hone up and down all the way through the bore. Follow the hone manufacturer's recommendations for wet or dry honing and oiling the hone.

5. Check the diameter of the cylinder regularly during honing. A dial bore gauge is the easiest method but a telescoping gauge can be used. Check the size at six places in the bore; measure twice at the top, middle and bottom at 90-degree angles.

6. When the cylinder is within about 0.002 inch of the desired bore, change to fine stones and finish the bore. The finish should not be smooth but crosshatched as shown. The crosshatch formed by the scratching of the stones should form an angle of 32 degrees. This can be achieved by moving the hone up and down in the cylinder about 40 times per minute.

7. Clean the cylinder block thoroughly with soap, water and clean rags. A clean white rag should not be soiled on the wall after cleaning is complete.

CAUTION: *Do not use a solvent or gasoline since they wash the oil from the walls but leave the metal particles.*

8. Dry the crankcase and coat it with oil.

Crankshaft and Bearings

CRANKSHAFT REMOVAL

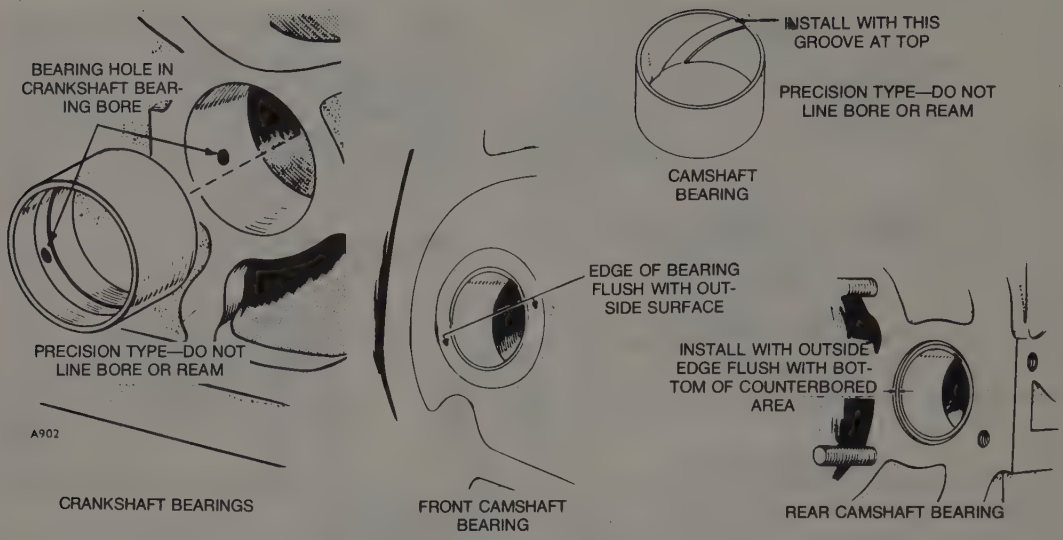
1. Remove the lock ring and retainer washer from the crankshaft gear, and pull off gear with a puller.

2. Remove the oil pan, head(s), pistons and rods. See the previous section on piston and ring service.

3. Remove the rear bearing plate. Remove the crankshaft through the rear opening in the crankcase.

INSPECTION

Clean the crankshaft thoroughly, including blowing out all oil passages with compressed air. Check the journals for out-of-round, taper, grooves, and ridges, and place on V-blocks and rotate to measure runout. It should not exceed .003". Compare all dimensions with specifications: out-of-round should not exceed .005 in.; staper should not exceed .001 in.; wear should not exceed .002 in. If the limits


BEARING HOLE IN CRANKSHAFT BEARING BORE
PRECISION TYPE—DO NOT LINE BORE OR REAM
A902
CRANKSHAFT BEARINGS
INSTALL WITH THIS GROOVE AT TOP
PRECISION TYPE—DO NOT LINE BORE OR REAM
CAMSHAFT BEARING
EDGE OF BEARING FLUSH WITH OUTSIDE SURFACE
FRONT CAMSHAFT BEARING
INSTALL WITH OUTSIDE EDGE FLUSH WITH BOTTOM OF COUNTERBORED AREA
REAR CAMSHAFT BEARING

Crankshaft main bearings and camshaft bearings for the AK series engines

are exceeded, regrind the shaft for the use of undersize bearings.

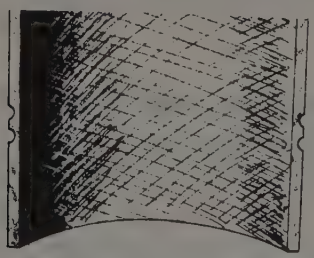
Replace bearings that are warped, scored, or have been overheated. If such damage is present, check the bearing bores in the block for excessive size. A new rear main bearing seat can be installed by replacing the rear main bearing plate. After doing this, check the main bearing bore alignment on a line boring machine.

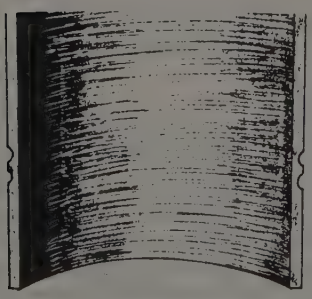
The main crankshaft bearings are precision bearings. They are available in the standard size as well as 0.002 in., 0.010 in., 0.020 in., and 0.030 in. undersize. The precision type bearings are *NOT* to be line reamed.

The bearings are press fit into the cylinder block. Before trying to install the bearing into the cylinder block or bearing plate, heat the plate or block by running hot water over them or placing them in an oven heated to 200° F. This will cause the block or bearing plate to expand and facilitate the installation of the sleeve bearings.

The oil hole in the bearing and the oil hole in the bearing bore must be aligned when the bearings are installed. On pressure lubricated engines, the hole should be opposite the crankshaft. On engines that are splash lubricated, the hole should be upward.

Install rear bearings in the rear bearing plate using a special driver. Install them to 1/64 in. below the end of the bore. If a special tool is not available and the lock pins must be removed with side cutters or a screw extractor, install new lock pins.





Produce a crosshatch in the bore as shown in the upper part of the illustration

CRANKSHAFT INSTALLATION

1. Oil the bearing surfaces thoroughly. Install the crankshaft from the rear of the crankcase (through the rear bearing plate hole).

2. Put the rear bearing plate gasket in place and lubricate the rear end plate bearing. Slide the thrust washer, with grooves toward the crankshaft and the bearing plate, over the end of the crankshaft.

NOTE: *Line up the thrust washer notches with the lock pins before tightening the end plate bolts, or the lock pins and thrust washer will be damaged.*

If you have trouble getting the thrust washer

to stay in place, it may be lubricated with a light coating of oil.

3. Torque the bearing plate bolts.

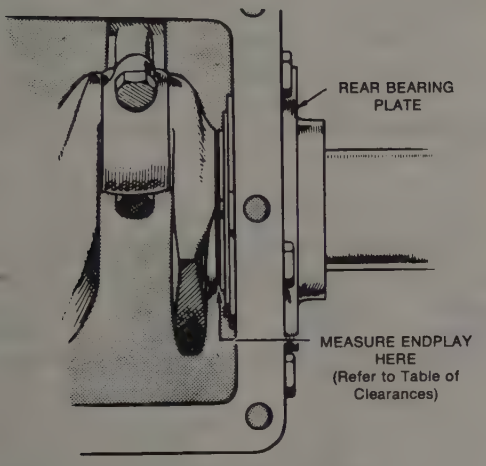
4. Heat the timing gear to 350° F. Install a new crankshaft key and drive the gear into position. Install the washer and lock ring.

5. Adjust the crankshaft end play as described below.

6. Complete the reassembly of the engine.

CHECKING END PLAY

Check the end play with the rear bearing plate bolts properly torqued. If end play is excessive, remove the end plate and install a shim between the thrust washer and plate. When installing the plate, line up the notches in the thrust washer and shim with the lock pins. Torque the end plate and recheck end play. If total gasket and shim thickness required is more than .015 in., use a steel shim of the proper thickness and two thin gaskets, or gasket compression and consequent loose bolts may result.



Measure end play at location shown

Crankshaft Oil Seals

The crankshaft oil seals are installed with the open sides facing toward the inside of the engine. To replace the rear oil seal, the rear bearing plate must be removed. To replace the front oil seal, the front gear cover must be removed. Be careful not to damage the oil seal during installation or to turn back the edge of the seal lip.

LUBRICATION

Onan engines are either splash lubricated or pressure lubricated.

The splash lubrication system consists of an oil dipper attached to the connecting rod cap and various oil passages to catch and channel the oil that is splashed up by the oil dipper.

The pressure lubrication system consists of a gear type oil pump, an oil intake cup, a non-adjustable pressure relief valve, and the various oil passages and channels.

Oil Pump

SERVICE

1. Drain the crankcase oil. Then, remove the gear cover and oil base.

2. Unscrew the intake cup from the oil pump. Loosen the two capscrews holding the pump and remove it.

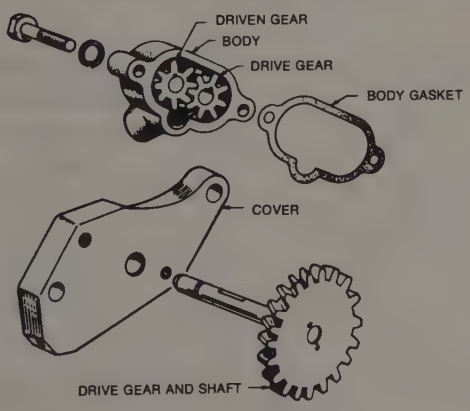
3. Disassemble the pump by removing the two cap screws holding the cover in position. Inspect for excessive wear of gears and shafts and replace the pump if any parts are badly damaged. Gears may be measured for excess wear by positioning them in the housing, running a straightedge across the sides of the housing, and inserting a flat feeler gauge between the straightedge and side of the gear. If either this clearance or the clearance between oil pump teeth is excessive, replace the unit.

4. In reassembling the pump, side clearance between gears and housing can be adjusted by using a thinner gasket. Use the thinnest gasket that permits freedom in operation of the pump.

5. CAUTION: *Fully prime the pump with oil before assembly.* Mount the pump into position on the engine and adjust for a clearance of .005 in. between the pump and crankshaft gears.

6. Install the intake cup on the pump parallel with the bottom of the crankcase.

7. Install the gear cover and oil base, fill the crankcase with oil, and run engine, checking for good oil pressure.



Exploded view of oil pump

Crankshaft and Connecting Rod Specifications

All measurements are given in inches

Engine Model	Crankshaft				Connecting Rod		
	Main Brg Journal Dia	Main Brg Oil Clearance	Shaft End-Play	Thrust on No.	Journal Diameter	Oil Clearance	Side Clearance
AK	1.6857–1.6865	.0030–.0040	.008–.0012	Rear	1.3742–1.3750	.0015–.0025	.012–.035
AJ	1.6857–1.6865	.0015–.0040	.008–.0012	Rear	1.3742–1.3750	.0015–.0025	.012–.035
LK	1.9992–2.000	.0020–.0030	.006–.0012	Rear	1.6252–1.6280	.0020–.0030	.002–.016

Valve Specifications

Engine Model	Seat Angle (deg)	Face Angle (deg)	Spring Test Pressure (lbs @ in.)	Spring Installed Height (in.)	Guide Diameter (in.)		Stem Diameter (in.)	
					Intake	Exhaust	Intake	Exhaust
AK	45	44	71–79 @ 1.313	—	.3110–.3120	.3110–.3120	.3095–.3100	.3090–.3100
AJ	45	44	71–79 @ 1.313	—	.3110–.3120	.3110–.3120	.3080–.3085	.3090–.3100
LK	45	44	71–79 @ 1.375	—	.3440–.3460	.3440–.3460	.3425–.3430	.3410–.3413

Piston Clearance

Engine Model	Piston to Bore Clearance (in.)
AK	.004–①.005
AJ	.006–①.008
LK	.0005–①.0015

① Measure piston diameter across dimension Y

Ring Gap

All measurements are given in inches

Engine Model	Top Compression	Bottom Compression	Oil Control
AK	.006–.018	.006–.018	.006–.018
AJ	.006–.024	.006–.024	.006–.024
LK	.010–.023	.010–.023	.010–.023

Ring Side Clearance

All measurements are given in inches

Engine Model	Top Compression
AK	.002–.008
AJ	.002–.008
LK	.002–.008

Torque Specifications

ENGINE SERIES		Use Engine Lubricating Oil As A Thread Lubricant					Do Not Use Any Lubricant On These Threads	
		Cylinder Head (Cold)	Conn Rod	Rear Bearing Plate	Flywheel To Crank-shaft	Oil Base	Armature Thru Stud / Revolving Armature Units	Spark Plugs
AJ, MAJ	lb-ft	24–26	10–12	20–25	35–40	25–30	25–30	25–30
AK	lb-ft	24–26	10–12	20–25	35–40	25–30	25–30	25–30
LK	lb-ft	29–31	26–28	20–25	35–40	25–30	35–40	25–30

9

Tecumseh-Lauson Light Frame 4-Stroke Engines

ENGINE IDENTIFICATION

Lauson 4 cycle engines are identified by a model number stamped on a nameplate. The nameplate is located on the crankcase of vertical shaft models and on the blower housing of horizontal shaft models.

A typical model number appears on the illustration showing the location of the nameplate for vertical crankshaft engines. This number is interpreted as follows:

- V—vertical shaft engine
- 60.—6.0 horsepower
- 70360J—the specification number. The last three numbers(360) indicate that this particular engine is a variation on the basic model line.
- 2361J—serial number
- 2—year of manufacture
- 361—the calendar day of manufacture
- J—line and shift location at the factory

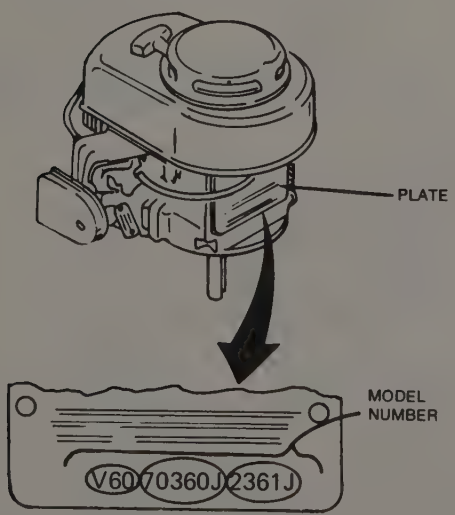
MAINTENANCE

Air Cleaner Service

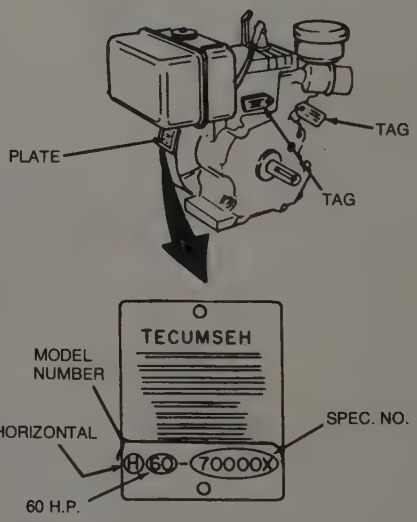
Service all the oil/foam polyurethane and oil bath air cleaner elements in the same manner as the Briggs and Stratton components. See Chapter Four.

The Tecumseh treated paper element type air cleaner consists of a pleated paper element encased in a metal housing and must be replaced as a unit. A flexible tubing and hose clamps connect the remotely mounted air filter to the carburetor.

Clean the element by lightly tapping it. Do not distort the case. When excessive carburetor adjustment or loss of power results, inspect the air filter to see if it is clogged. Replacing a severely restricted air filter should show an immediate performance improvement.



Vertical engine identification



Horizontal engine identification

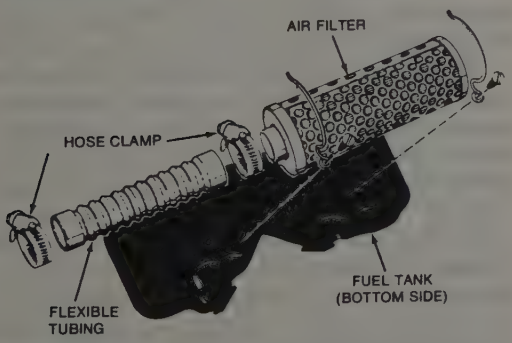
General Engine Specifications Vertical Crankshaft Engines

Model	Bore & Stroke	Displacement	Horsepower
LAV25	2.3125×1.8438	7.75	2½
LAV30	2.3125×1.8438	7.75	3
TVS75	2.3125×1.8438	7.75	3
LV35	2.5000×1.8438	9.06	3½
LAV35	2.5000×1.8438	9.06	3½
TVS90	2.5000×1.8438	9.06	3½
LAV40	2.6250×1.9375	10.5	4
TVS105	2.6250×1.9375	10.5	4
V40, V40B	2.5000×2.2500	11.04	4
VH40	2.5000×2.2500	11.04	4
LAV50	2.812×1.9375	12.0	5
TVS120	2.812×1.9375	12.0	5
V50	2.625×2.2500	12.17	5
VH50	2.625×2.2500	12.17	5

Check the oil level in the oil bath type air cleaners regularly to make sure the level is correct. To add oil, unscrew the wingnut, pull off the filter element and add oil along the side of the filter until the level is correct. Use the same type and viscosity oil used in the engine.

If the filter is dirty, remove it and wash it in solvent. Also remove the filter bowl, drain the oil, and wash the filter in solvent. Refill the bowl with clean oil after putting it into position on the air horn.

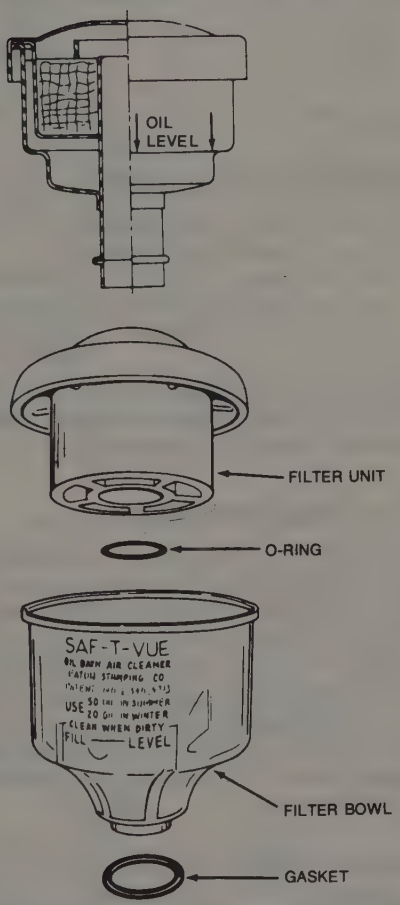
A plain paper element is also used. It should be removed every 10 hours, or more often if the air is dusty. Tap or blow out the dirt from the inside with low pressure air. This type should be replaced at 50 hours. If clogged sooner, it may be washed in soap and water and rinsed by flushing from the inside until the water is clear. Blow dry with low pressure compressed air.



Treated paper element air cleaner (used on Craftsman engines)

General Engine Specifications Horizontal Crankshaft Engines

Model	Bore & Stroke (in.)	Displacement (cu in.)	Horsepower
H25	2.3125×1.8438	7.75	2½
H30	2.3125×1.8438	7.75	3
H35	2.5000×1.8438	9.06	3½
H40	2.5000×2.2500	11.04	4
HH40	2.5000×2.2500	11.04	4
HS40	2.6250×1.9375	10.5	4
H50	2.6250×2.2500	12.17	5
HH50	2.6250×2.2500	12.17	5
HS50	2.8120×1.9375	12.0	5



Exploded view of oil bath type air cleaner

To service the KLEEN-AIRE® system, remove the element, wash it in soap and mild detergent, pat dry, and then coat with oil. Squeeze the oil to distribute it evenly and remove the excess. Make sure all mounting surfaces are tight to prevent leakage.

Lubrication

OIL AND FUEL RECOMMENDATIONS

Use fresh (less than one month old) gasoline, of "Regular" grade. Unleaded fuel is preferred, but leaded fuel is acceptable.

Use oil having MS, SC, SD, or SE classification. Use these viscosities for aluminum engines:

- **Summer**—above 32°F.—S.A.E. 30 (S.A.E. 10W30 or 10W40 are acceptable substitutes).
- **Winter**—Below 32°F.—S.A.E. 5W30 (S.A.E. 10W is an acceptable substitute). (Including Snow King Snow Blower Engines)
- **Winter**—Below 0° only S.A.E. 10W diluted with 10% kerosene is an acceptable substitute. (Including Snow King Snow Blower Engines)

Use these viscosities for cast iron engines:

- **Summer**—Above 32°F.—S.A.E. 30
- **Winter**—Above 32°F.—S.A.E. 10W

TUNE-UP

Tune-Up Specifications

The following basic specifications apply to all the engines covered in this section:

- Spark Plug Gap: .030 in.
- Ignition Point Gap: .020 in.
- Valve Clearance: .010 in. for both intake and exhaust

For timing dimension, which varies from engine to engine, see the complete specifications at the rear of this section.

Spark Plug Service

Spark plugs should be removed, cleaned, and adjusted periodically. Check the electrode gap with a wire feeler gauge and adjust the gap. Replace the plugs if the electrodes are pitted and burned or the porcelain is cracked. Refer to the Tecumseh master parts manual for the correct replacement number. Apply a little graphite grease to the threads to prevent sticking. Be sure the cleaned plugs are free of all foreign material.

Breaker Points

ADJUSTMENT

1. Disconnect the fuel line from the carburetor.
2. Remove the mounting screws, fuel tank, and shroud to provide access to the flywheel.
3. Remove the flywheel with either a puller (over 3.5 hp) or by using a screwdriver to pry underneath the flywheel while tapping the top lightly with a soft hammer.
4. Remove the dust cover and gasket from the magneto and crank the engine over until the breaker points of the magneto are fully opened.
5. Check the condition of the points and replace them if they are burned or pitted.
6. Check the point gap with a feeler gauge. Adjust them, if necessary, as per the directions on the dust cover. Refer to the specifications chart at the end of this chapter for point gap.

REPLACEMENT

1. Gain access to the points and inspect them as described above. If the points are badly pitted, follow the remaining steps to replace them.
2. Remove the nuts that hold the elctrical leads to the screw on the movable breaker point spring. Remove the movable breaker point from stud.
3. Remove the screw and stationary breaker point. Put a new stationary breaker point on the breaker plate; install the screw, but do not tighten. This point must be moved to make the proper air gap when the points are adjusted.
4. Position a new movable breaker point on the stud.
5. Adjust the breaker point gap with a flat feeler gauge and tighten the screw.
6. Check the new point contact pattern and remove all grease, finger-prints, and dirt from contact surfaces.
7. Adjust the timing as described below.

Ignition Timing

ADJUSTMENT

1. Remove the cylinder head bolts, and move the head (with gasket in place) so that the spark plug hole is centered over the piston.
2. Using a ruler (through the spark plug hole) or special plunger type tool, carefully turn the engine back and forth until the piston is at exactly Top Dead Center. Tighten the thumbscrew on the tool.
3. Find the timing dimension for your engine in the specifications at the rear of the manual. Then, back off the position of the piston until it is about halfway down in the bore. Lower the ruler (or loosen the thumbscrew and lower the plunger, if using the special tool) exactly the required amount (the amount of the timing dimension). Then, hold the ruler in place (or tighten the special tool thumbscrew) and, finally, carefully rotate the engine forward until the piston just touches the ruler or tool plunger.
4. Install a timing light or place a very thin

piece of cellophane between the contact points. Loosen and rotate the stator just until the timing light shows a change in current flow or the cellophane pulls out of contact gap easily. Then, tighten stator bolts to specified torque.

5. Install the leads, point cover, flywheel, and shrouding.

SOLID STATE IGNITION SYSTEM CHECKOUT

The only on-engine check which can be made to determine whether the ignition system is working, is to separate the high tension lead from the spark plug and check for spark. If there is a spark, then the unit is alright and the spark plug should be replaced. No spark indicates that some other part needs replacing.

Check the individual components as follows:

- High Tension Lead: Inspect for cracks or indications of arcing. Replace the transformer if the condition of the lead is questionable.
- Low Tension Leads: Check all leads for shorts. Check the ignition cut-off lead to see that the unit is not grounded. Repair the leads, if possible, or replace them.
- Pulse Transformer: Replace and test for spark.
- Magneto: Replace and test for spark. Time the magneto by turning it counterclockwise as far as it will go and then tighten the retaining screws.
- Flywheel: Check the magnets for strength. With the flywheel off the engine, it should attract a screwdriver that is held 1 in. from the magnetic surface on the inside of the flywheel. Be sure that the key locks the flywheel to the crankshaft.

Carburetor Mixture Adjustments

1. If the carburetor has been overhauled, or the engine won't start, make initial mixture screw adjustments as specified in the chart.

2. Start the engine and allow it to warm up to normal running temperature. With the engine running at maximum recommended rpm, loosen the main adjustment screw until engine rpm drops off, then tighten the screw until the engine starts to cut out. Note the number of turns from one extreme to the other. Loosen the screw to a point midway between the extremes.

NOTE: *Some carburetors have fixed jets. If there is no main adjusting screw and receptacle, no adjustment is needed.*

Chart of Initial Carburetor Adjustments

Adjustment	For Engines Built Prior to 1977	For Engines Built After 1977
Main Adjustment	V50-60-1¼ H50-60-1¼	Same
Idle Adjustment	V50-60-70-1 Turn H50-60-70-1 Turn	Same
Idle Speed (Top of Carburetor) Regulating screw	Back out screw, then turn in until screw just touches throttle lever and continue 1 turn more (if idle RPM is given set final idle speed with a tachometer)	

3. After the main system is adjusted, move the speed control lever to the idle position and follow the same procedure for adjusting the idle system.

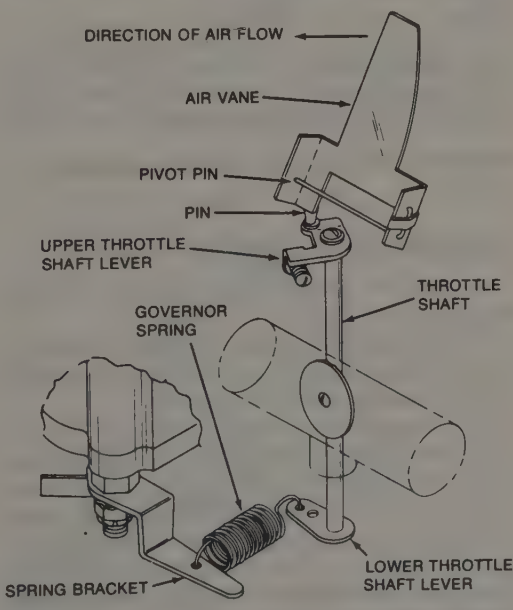
4. Test the engine by running it under a normal load. The engine should respond to load pickup immediately. An engine that "dies" is too lean. An engine which ran roughly before picking up the load is adjusted too rich.

Governor

ADJUSTMENT

Air Vane Type

1. Operate the engine with the governor adjusting lever or panel control set to the highest possible speed position and check the



Schematic of the operation of an air vane governor

speed. If the speed is not within the recommended limits, the governed speed should be adjusted.

2. Loosen the locknut on the high speed limit adjusting screw and turn the adjusting screw out to increase the top engine speed.

Mechanical Type

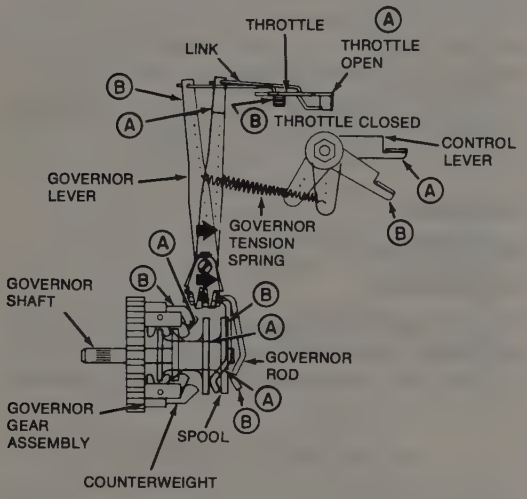
1. Set the control lever to the idle position so that no spring tension affects the adjustment.

2. Loosen the screw so that the governor lever is loose in the clamp.

3. Rotate both the lever and the clamp to move the throttle to the full open position (away from the idle speed regulating screw).

4. Tighten the screw when no end-play exists in the direction of open throttle.

5. Move the throttle lever to the full speed setting and check to see that the control linkage opens the throttle.



Schematic of mechanical governor operation

Compression Check

1. Run the engine until warm to lubricate and seal the cylinder.

2. Remove the spark plug and install a compression gauge. Turn the engine over with the pull starter or electric starter.

3. Compression on new engines is 80 psi. If the reading is below 60 psi., repeat the test after removing the gauge and squirting about a teaspoonful of engine oil through the spark plug hole. If the compression improves temporarily following this, the problem is probably with the cylinder, piston, and rings. Otherwise, the valves require service.

FUEL SYSTEM

Carburetor

NOTE: *Four-cycle Tecumseh engines use float or diaphragm type carburetors.*

REMOVAL AND INSTALLATION

1. Drain the fuel tank. Remove the air cleaner and disconnect the carburetor fuel lines.

2. If necessary, remove any shrouding or control panels to provide access to carburetor.

3. Disconnect the choke or throttle control wires at the carburetor.

4. Remove the cap screws, or nuts and lockwashers that hold the carburetor to the engine; remove the carburetor.

5. Secure the carburetor on to engine.

6. Install the shrouding or control panels. Connect the choke and throttle control wires.

7. Position the control panel to carburetor. Connect the carburetor fuel lines.

8. Install the air cleaner.

9. Adjust the carburetor as described above.

GENERAL OVERHAUL INSTRUCTIONS

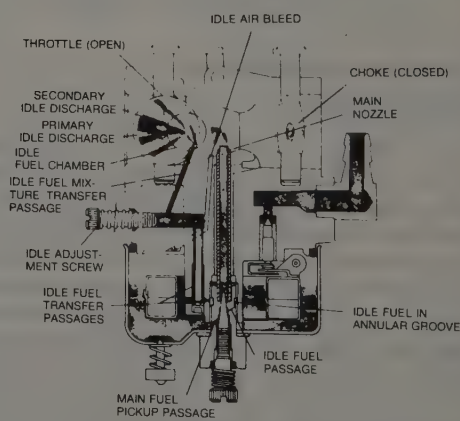
1. Carefully disassemble the carburetor removing all non-metallic parts, i.e.; gaskets, viton seats and needles, O-rings, fuel pump valves, etc.

NOTE: *Nylon check balls used in some diaphragm carburetor models may or may not be serviceable. Check to be sure of serviceability before attempting removal.*

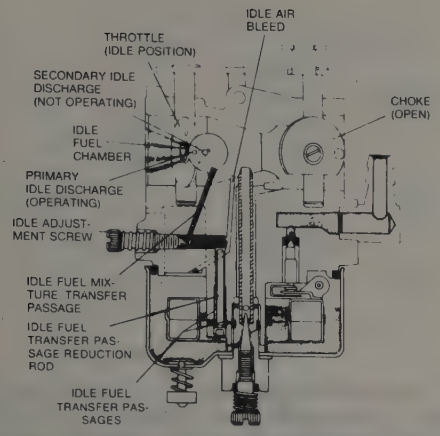
2. Clean all metallic parts with solvent.

NOTE: *Nylon can be damaged if subjected to harsh cleaners for prolonged periods.*

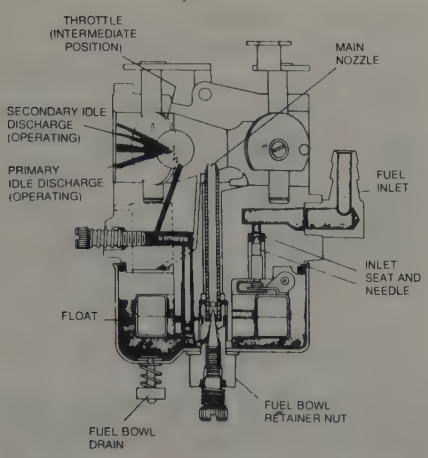
3. The large O-rings sealing the fuel bowl to the carburetor body must be in good con-



The choke position on a float feed carburetor. The closed choke plate restricts air, creating a richened mixture by drawing in a greater proportion of fuel.



The idle operation of a float feed carburetor. The throttle plate closes, restricting the flow of fuel and air, forcing the engine to run on a reduced volume of fuel and air.



The intermediate operation of a float feed carburetor. The throttle plate "cracks" open to reduce the restriction and the engine runs on an increased volume of fuel and air.

dition to prevent leakage. If the O-ring leaks, interfering with the atmospheric pressure in the float bowl, the engine will run rich. Foreign material can enter through the leaking area and cause blocking of the metering orifices. This O-ring should be replaced after the carburetor has been disassembled for repair. Lubricate the new O-ring with a small amount of oil to allow the fuel bowl to slide onto the O-ring properly. Hold the carburetor body in an inverted position and place the O-ring on the carburetor body and then position the fuel bowl.

4. The small O-rings used on the carburetor adjustment screws must be in good condition or a leak will develop and cause improper adjustment of carburetor.

5. Check all adjusting screws for wear. The illustration shows a worn screw and a good screw. Replace screws that are worn.

6. Check the carburetor inlet needle and seat for wear, scoring, or other damage. Replace defective parts.

7. Check the carburetor float for dents, leaks, worn hinge or other damage.

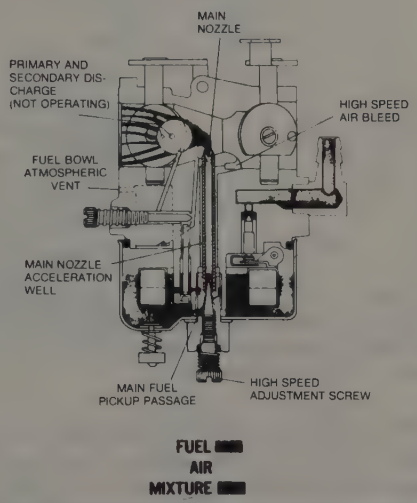
8. Check the carburetor body for cracks, clogged passages, and worn bushings. Clean clogged air passages with clean, dry compressed air.

9. Check the diaphragms on diaphragm carburetors for cracks, punctures, distortion, or deterioration.

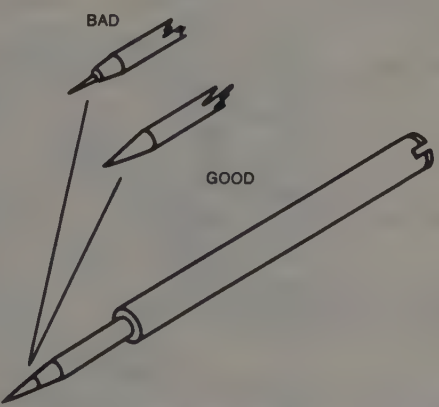
10. Check all shafts and pivot pins for wear on the bearing surfaces, distortion, or other damage.

NOTE: *Each time a carburetor is disassembled, it is good practice to install a repair kit.*

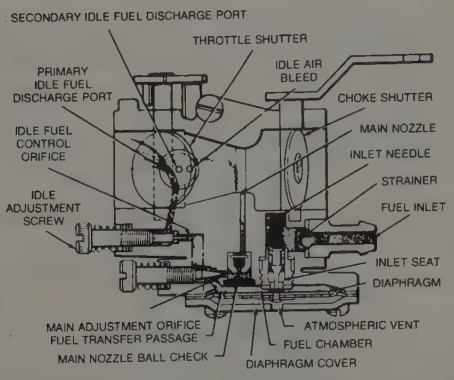
11. Where there is excessive vibration, a damper spring may be used to assist in hold-



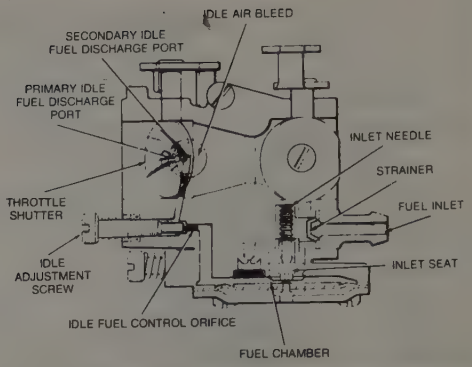
The high speed operation of a float feed carburetor. The air venturi replaces the throttle plate as the restricting device and the engine runs on its greatest volume of fuel and air.



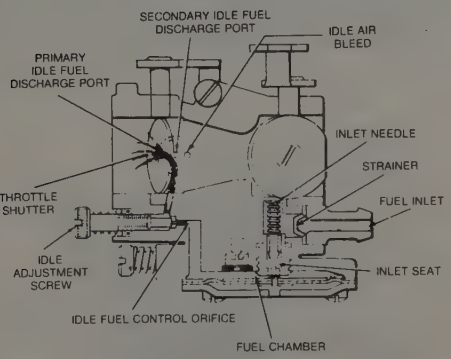
Appearance of good and bad mixture adjusting screws



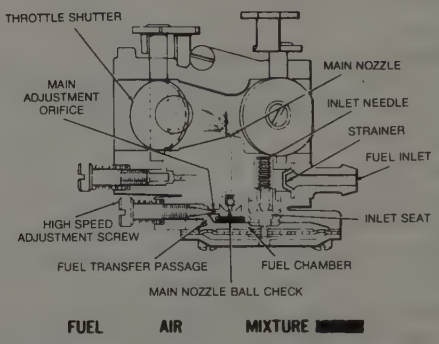
The choke position of the diaphragm carburetor. The closed choke plate restricts the amount of air, creating a richened mixture by drawing in a greater proportion of fuel.



The intermediate operation of a diaphragm carburetor. The throttle plate "cracks" to decrease the restriction and the engine runs on an increased volume of fuel and air.



The idling operation of a diaphragm carburetor. The throttle plate closes, restricting the flow of fuel and air, forcing the engine to run on a reduced volume of fuel and air.

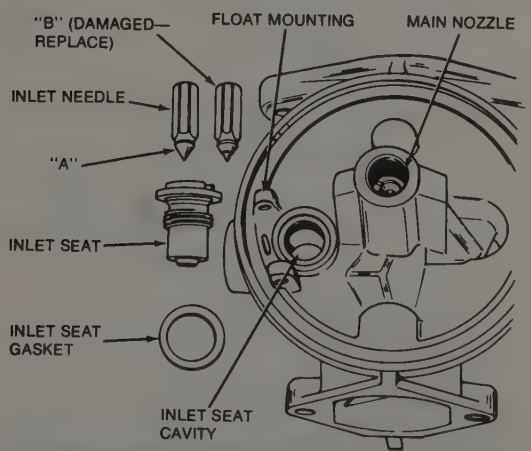


The high speed operation of a diaphragm carburetor. The air ventui replaces the throttle plate as the restricting device and the engine runs on its greatest volume of fuel and air.

ing the float against the inlet needle thus minimizing the flooding condition. Two types of springs are available; the float shaft (hinge pin) type and the inlet needle mounted type.

12. Float shaft spring positioning:

a. The spring is slipped over the shaft.



Appearance of good and bad inlet needles

b. The rectangular shaped spring end is hooked onto the float tab.

c. The shorter angled spring end is placed onto the float bowl gasket support.

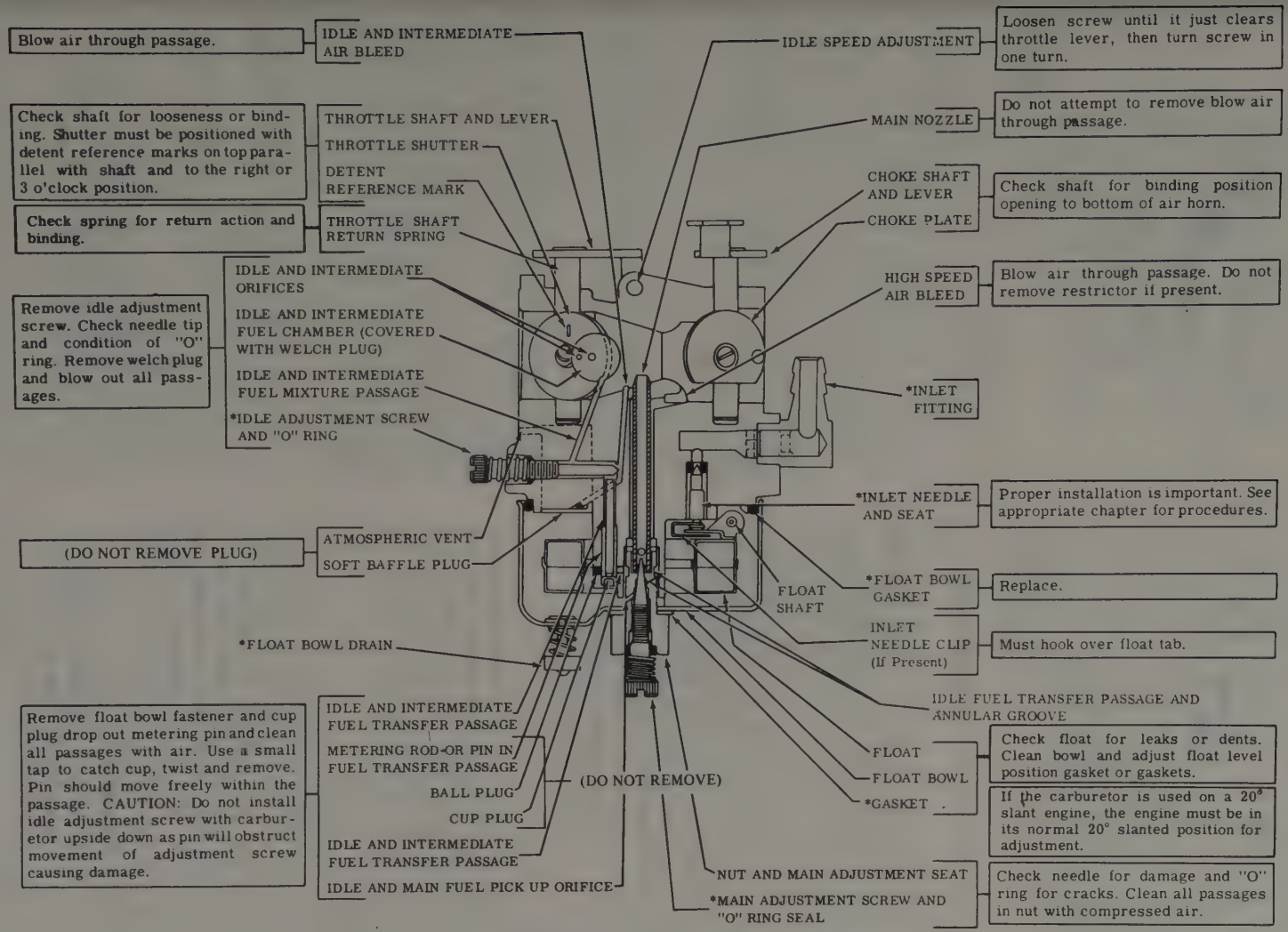
13. Note that on late model carburetors, the spring clip fastened to the inlet needle has been revised to provide a damping effect. The clip fastens to the needle and is hooked over the float tab.

FLOAT FEED CARBURETOR

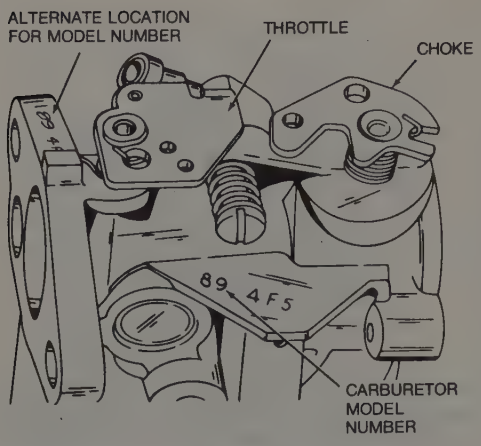
Note the following points when rebuilding these carburetors.

Removal

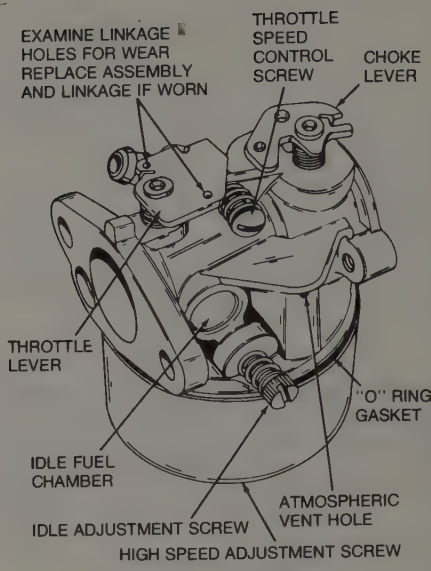
Remove the carburetor from the engine. It is easier to remove the intake manifold and carburetor assembly from the engine, disconnect the governor linkage, fuel line, and grounding wire and then disassemble the carburetor from the intake manifold on a work bench. Be sure to note the positions of the governor and the throttle linkage to facilitate reassembly.


Blow air through passage.
IDLE AND INTERMEDIATE AIR BLEED
IDLE SPEED ADJUSTMENT
Loosen screw until it just clears throttle lever, then turn screw in one turn.
Check shaft for looseness or binding. Shutter must be positioned with detent reference marks on top parallel with shaft and to the right or 3 o'clock position.
THROTTLE SHAFT AND LEVER
THROTTLE SHUTTER
DETENT REFERENCE MARK
MAIN NOZZLE
Do not attempt to remove blow air through passage.
CHOKE SHAFT AND LEVER
Check shaft for binding position opening to bottom of air horn.
CHOKE PLATE
Check spring for return action and binding.
THROTTLE SHAFT RETURN SPRING
HIGH SPEED AIR BLEED
Blow air through passage. Do not remove restrictor if present.
IDLE AND INTERMEDIATE ORIFICES
Remove idle adjustment screw. Check needle tip and condition of "O" ring. Remove welch plug and blow out all passages.
IDLE AND INTERMEDIATE FUEL CHAMBER (COVERED WITH WELCH PLUG)
IDLE AND INTERMEDIATE FUEL MIXTURE PASSAGE
*IDLE ADJUSTMENT SCREW AND "O" RING
*INLET FITTING
*INLET NEEDLE AND SEAT
Proper installation is important. See appropriate chapter for procedures.
(DO NOT REMOVE PLUG)
ATMOSPHERIC VENT
SOFT BAFFLE PLUG
*FLOAT BOWL GASKET
Replace.
FLOAT SHAFT
INLET NEEDLE CLIP (If Present)
Must hook over float tab.
*FLOAT BOWL DRAIN
IDLE FUEL TRANSFER PASSAGE AND ANNULAR GROOVE
Remove float bowl fastener and cup plug drop out metering pin and clean all passages with air. Use a small tap to catch cup, twist and remove. Pin should move freely within the passage. CAUTION: Do not install idle adjustment screw with carburetor upside down as pin will obstruct movement of adjustment screw causing damage.
IDLE AND INTERMEDIATE FUEL TRANSFER PASSAGE
METERING ROD OR PIN IN FUEL TRANSFER PASSAGE
BALL PLUG
CUP PLUG
(DO NOT REMOVE)
IDLE AND INTERMEDIATE FUEL TRANSFER PASSAGE
IDLE AND MAIN FUEL PICK UP ORIFICE
FLOAT
FLOAT BOWL
*GASKET
Check float for leaks or dents. Clean bowl and adjust float level position gasket or gaskets.
If the carburetor is used on a 20° slant engine, the engine must be in its normal 20° slanted position for adjustment.
NUT AND MAIN ADJUSTMENT SEAT
*MAIN ADJUSTMENT SCREW AND "O" RING SEAL
Check needle for damage and "O" ring for cracks. Clean all passages in nut with compressed air.

Service hints for float feed carburetors



Float feed carburetor identification number



External view of a Tecumseh float type carburetor

Throttle

1. Examine the throttle lever and plate prior to disassembly. Replace any worn parts.

2. Remove the screw in the center of the throttle plate and pull out the throttle shaft lever assembly.

3. When reassembling, it is important that the lines on the throttle plate are facing out when in the closed position. Position the throttle plates with the two lines at 12 and 3 o'clock. The throttle shaft must be held in tight to the bottom bearing to prevent the throttle plate from riding on the throttle bore of the body which would cause excessive throttle plate wear and governor hunting.

Choke

Examine the choke lever and shaft at the bearing points and holes into which the linkage is fastened and replace any worn parts. The choke plate is inserted into the air horn of the carburetor in such a way that the flat surface of the choke is toward the fuel bowl.

Idle Adjusting Screw

Remove the idle screw from the carburetor body and examine the point for damage to the seating surface on the taper. If damaged, replace the idle adjusting needle. Tension is maintained on the screw with a coil spring and sealed with an O-ring. Examine and replace the O-ring if it is worn or damaged.

High Speed Adjusting Jet

Remove the screw and examine the taper. If the taper is damaged at the area where it seats, replace the screw and fuel bowl retainer nut as an assembly.

The fuel bowl retainer nut contains the seat for the screw. Examine the sealing O-ring on the high speed adjusting screw. Replace the O-ring if it indicates wear or cuts. During the reassembly of the high speed adjusting screw, position the coil spring on the adjusting screw, followed by the small brass washer and the O-ring seal.

Fuel Bowl

To remove the fuel bowl, remove the retaining nut and fiber washer. Replace the nut if it is cracked or worn.

The retaining nut contains the transfer passage through which fuel is delivered to the high speed and idle fuel system of the carburetor. It is the large hole next to the hex nut end of the fitting. If a problem occurs with the idle system of the carburetor, examine the small fuel passage in the annular groove in the retaining nut. This passage must be clean for the proper transfer of fuel into the idle metering system.

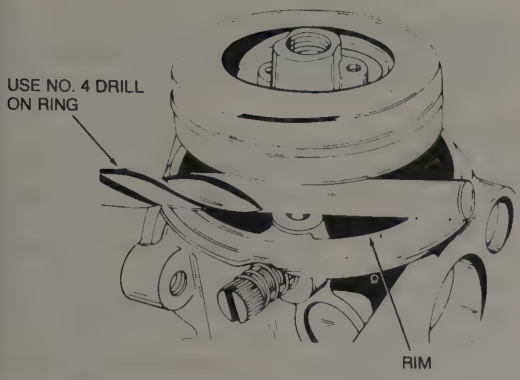
The fuel bowl should be examined for rust and dirt. Thoroughly clean it before installing it. If it is impossible to properly clean the fuel bowl, replace it.

Check the drain valve for leakage. Replace the rubber gasket on the inside of the drain valve if it leaks.

Examine the large O-ring that seals the fuel bowl to the carburetor body. If it is worn or cracked, replace it with a new one, making sure the same type is used (square or round).

Float

1. Remove the float from the carburetor body by pulling out the float axle with a pair of needle nose pliers. The inlet needle will be lifted off the seat because it is attached to the float with an anchoring clip.



Adjusting the float level

2. Examine the float for damage and holes. Check the float hinge for wear and replace it if worn.

3. The float level is checked by positioning a #4 (0.209 in.) twist drill across the rim between the center leg and the unmachined surface of the index pad, parallel to the float axle pin. If the index pad is machined, the float setting should be made with a #9 (0.180–0.200 in.) twist drill.

4. Remove the float to make an adjustment. Bend the tab on the float hinge to correct the float setting.

NOTE: *Direct compressed air in the opposite direction of normal flow of air or fuel (reverse taper) to dislodge foreign matter.*

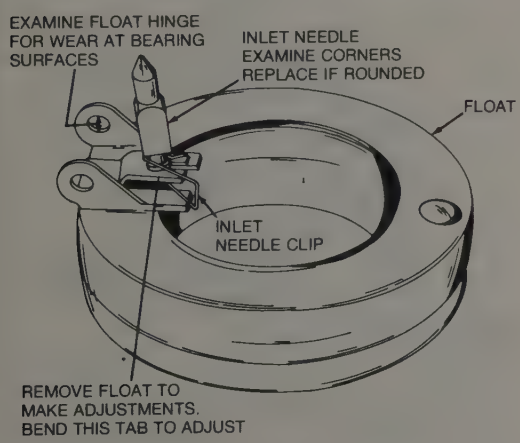
Inlet Needle and Seat

1. The inlet needle sits on a rubber seat in the carburetor body instead of the usual metal fitting.

2. Remove it, place a few drops of heavy engine oil on the seat, and pry it out with a short piece of hooked wire.

3. The grooved side of the seat is inserted first. Lubricate the cavity with oil and use a flat faced punch to press the inlet seat into place.

4. Examine the inlet needle for wear and rounding off of the corners. If this condition does exist, replace the inlet needle.



Float, inlet needle, and clip

Fuel Inlet Fitting

1. The inlet fitting is removed by twisting and pulling at the same time.

2. Use sealer when reinstalling the fitting. Insert the tip of the fitting into the carburetor body. Press the fitting in until the shoulder contacts the carburetor. Only use inlet fittings without screens.

Carburetor Body

1. Check the carburetor body for wear and damage.

2. If excessive dirt has accumulated in the atmospheric vent cavity, try cleaning it with carburetor solvent or compressed air. Remove the welch plug only as a last resort.

NOTE: *The carburetor body contains a pressed-in main nozzle tube at a specific depth and position within the venturi. Do not attempt to remove the main nozzle. Any change in nozzle positioning will adversely affect the metering quality and will require carburetor replacement.*

3. Clean the accelerating well around the main nozzle with compressed air and carburetor cleaning solvents.

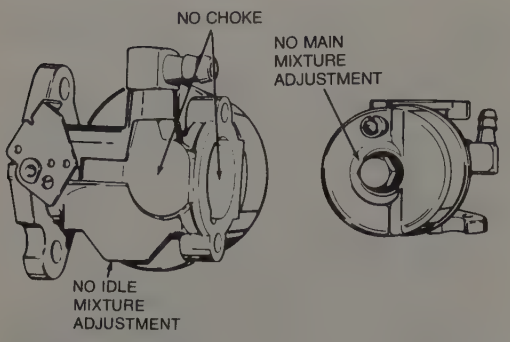
4. The carburetor body contains two cup plugs, neither of which should be removed. A cup plug located near the inlet seat cavity, high up on the carburetor body, seals off the idle bleed. This is a straight passage drilled into the carburetor throat. Do not remove this plug. Another cup plug is located in the base where the fuel bowl nut seals the idle fuel passage. Do not remove this plug or the metering rod.

5. A small ball plug located on the side of the idle fuel passage seals this passage. Do not remove this ball plug.

6. The welch plug on the side of the carburetor body, just above the idle adjusting screw, seals the idle fuel chamber. This plug can be removed for cleaning of the idle fuel mixture passage and the primary and secondary idle fuel discharge ports. Do not use any tools that might change the size of the discharge ports, such as wire or pins.

Resilient Tip Needle

Replace the inlet needle. Do not attempt to remove or replace the seat in the carburetor body.



Auto-Magic carburetor

Viton Seat

Using a 10-24 or 10-32 tap, turn the tap into the brass seat fitting until it grasps the seat firmly. Clamp the tap shank into a vise and tap the carburetor body with a soft hammer until the seat slides out of the body.

To replace the viton seat, position the replacement over the receptical with the soft rubber like seat toward the body. Use a flat punch and a small hammer to drive the seat into the body until it bottoms on the shoulder.

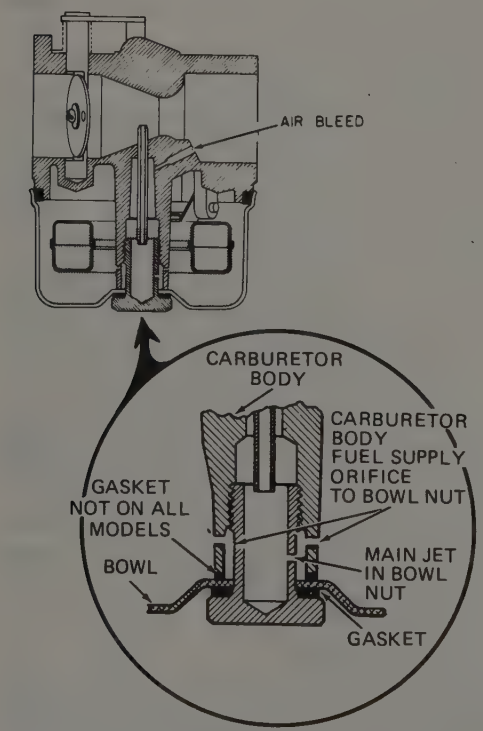
TECUMSEH AUTOMATIC NON-ADJUSTABLE FLOAT FEED CARBURETOR

This carburetor has neither a choke plate nor idle and main mixture adjusting screws. There is no running adjustment. The float adjustment is the standard Tecumseh float setting of 0.210 in. (#4 drill).

Cleaning

Remove all non-metallic parts and clean them using a procedure similar to that for the other carburetors. Never use wires through any of the drilled holes. Do not remove the baffling welch plug unless it is certain there is a blockage under the plug. There are no blind passageways in this carburetor.

Some engines use a variation on the Automatic Nonadjustable carburetor which has a different bowl hold—on nut and main jet orifices. There are two main jet orifices and a deeper fuel reserve cavity, but service procedures are the same.



Variation on non-adjustable float feed carburetor

WALBRO AND TILLOTSON FLOAT FEED CARBURETORS

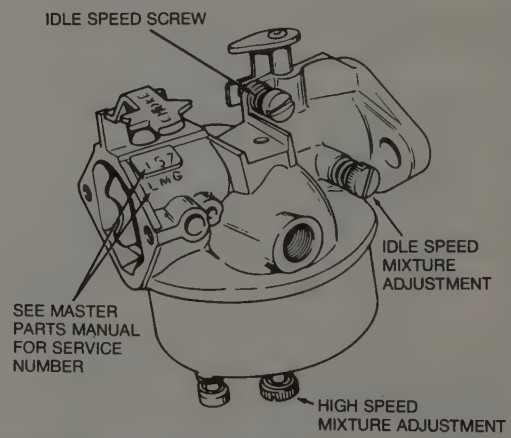
Procedures are similar to those for the Tecumseh float carburetor with the exceptions noted below.

Main Nozzle

The main nozzle in Wallbro carburetors is cross drilled after it is installed in the carburetor. Once removed, it cannot be reinstalled, since it is impossible to properly realign the cross drilled holes. Grooved service replacement main nozzles are available which allow alignment of these holes.

Float Shaft Spring

Carefully position the float shaft spring on models so equipped. The spring dampens float action when properly assembled. Use needle-nosed pliers to hook the end of the spring over the float hinge and then insert the pin as far as possible before lifting the spring from the hinge into position. Leaving the spring out or im-


IDLE SPEED SCREW
IDLE SPEED MIXTURE ADJUSTMENT
SEE MASTER PARTS MANUAL FOR SERVICE NUMBER
HIGH SPEED MIXTURE ADJUSTMENT

Walbro float feed carburetor

proper installation will cause unbalanced float action and result in a touchy adjustment.

Float Adjustment

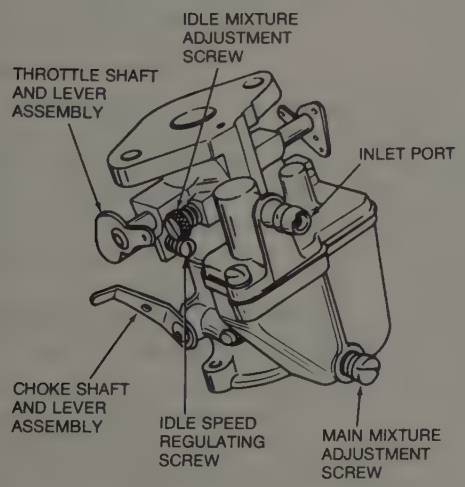
1. To check the float adjustment, invert the assembled float carburetor body. Check the clearance between the body and the float, opposite the hinge. Clearance should be ⅛ in. ± 1/64 in.
2. To adjust the float level, remove the float shaft and float. Bend the lip of the float tang to correct the measurement.
3. Assemble the parts and recheck the adjustment.

TILLOTSON E FLOAT FEED TYPE CARBURETOR

The following adjustments are different for this carburetor.

Running Adjustment

1. Start the engine and allow it to warm up to operating temperatures. Make sure the choke is fully opened after the engine is warmed up.
2. Run the engine at a constant speed while slowly turning the main adjustment screw in until the engine begins to lose speed; then slowly back it out about ⅛–¼ of a turn until maximum speed and power is obtained (4000 rpm). This is the correct power adjustment.
3. Close the throttle and cause the engine to idle slightly faster than normal by turning the idle speed regulating screw in. Then turn the idle adjustment speed screw in until the engine begins to lose speed; then turn it back ¼ to ½ of a turn until the engine idles smoothly. Adjust the idle speed regulating screw until the desired idling speed is acquired.


IDLE MIXTURE ADJUSTMENT SCREW
THROTTLE SHAFT AND LEVER ASSEMBLY
INLET PORT
CHOKE SHAFT AND LEVER ASSEMBLY
IDLE SPEED REGULATING SCREW
MAIN MIXTURE ADJUSTMENT SCREW

Tillotson Model E float carburetor

4. Alternately open and close the throttle a few times for an acceleration test. If stalling occurs at idle speeds, repeat the adjustment procedures to get the proper idle speed.

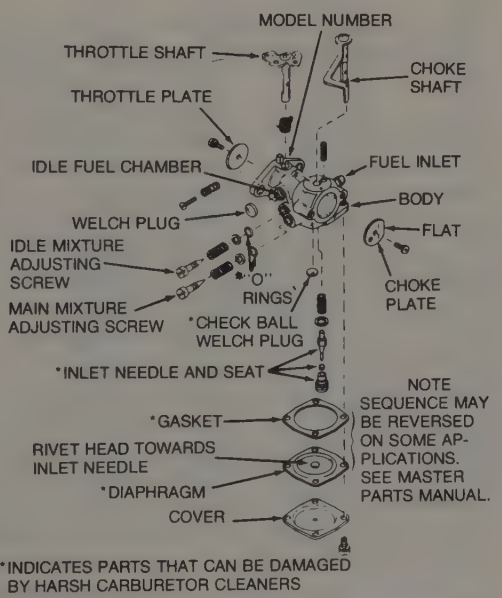
Float Level Adjustment

1. Remove the carburetor float bowl cover and float mechanism assembly.
2. Remove the float bowl cover gasket and, with the complete assembly in an upside down position and the float lever tang resting on the seated inlet needle, a measurement of 1 5/64 in. should be maintained from the free end flat rim, or edge of the cover, to the toe of the float. Measurement can be checked with a standard straight rule or depth gauge.
3. If it is necessary to raise or lower the float lever setting, remove the float lever pin and the float, then carefully bend the float lever tang up or down as required to obtain the correct measurement.

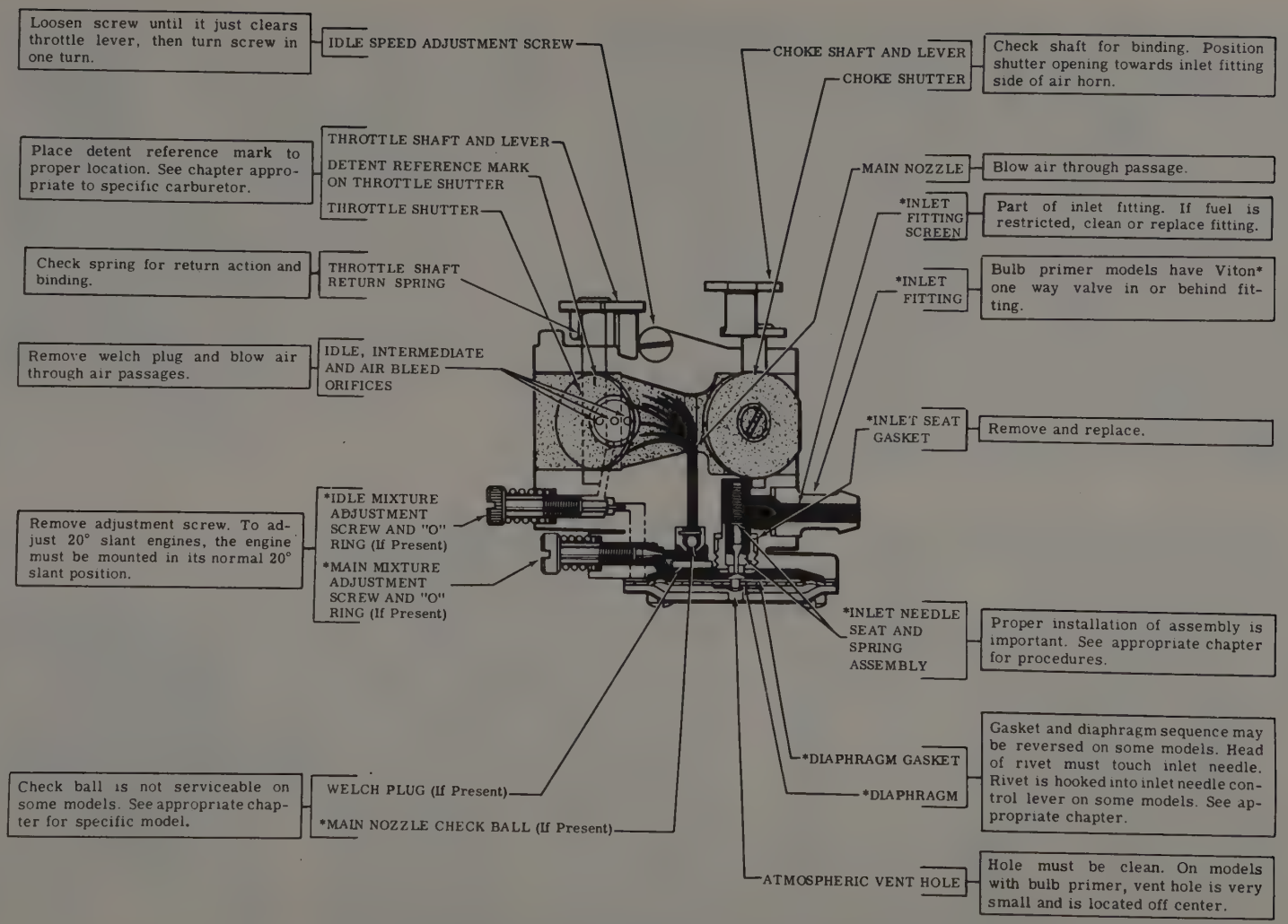
DIAPHRAGM CARBURETORS

Diaphragm carburetors have a rubber-like diaphragm that is exposed to crankcase pressure on one side and to atmospheric pressure on the other side. As the crankcase pressure decreases, the diaphragm moves against the inlet needle allowing the inlet needle to move from its seat which permits fuel to flow through the inlet valve to maintain the correct fuel level in the fuel chamber.

An advantage of this type of system over the float system, is that the engine can be operated in any position.



Exploded view of a Tecumseh diaphragm carburetor


Loosen screw until it just clears throttle lever, then turn screw in one turn.
IDLE SPEED ADJUSTMENT SCREW
CHOKE SHAFT AND LEVER
CHOKE SHUTTER
Check shaft for binding. Position shutter opening towards inlet fitting side of air horn.
Place detent reference mark to proper location. See chapter appropriate to specific carburetor.
THROTTLE SHAFT AND LEVER
DETENT REFERENCE MARK ON THROTTLE SHUTTER
THROTTLE SHUTTER
MAIN NOZZLE
Blow air through passage.
*INLET FITTING SCREEN
Part of inlet fitting. If fuel is restricted, clean or replace fitting.
Check spring for return action and binding.
THROTTLE SHAFT RETURN SPRING
*INLET FITTING
Bulb primer models have Viton* one way valve in or behind fitting.
Remove welch plug and blow air through air passages.
IDLE, INTERMEDIATE AND AIR BLEED ORIFICES
*INLET SEAT GASKET
Remove and replace.
Remove adjustment screw. To adjust 20° slant engines, the engine must be mounted in its normal 20° slant position.
*IDLE MIXTURE ADJUSTMENT SCREW AND "O" RING (If Present)
*MAIN MIXTURE ADJUSTMENT SCREW AND "O" RING (If Present)
*INLET NEEDLE SEAT AND SPRING ASSEMBLY
Proper installation of assembly is important. See appropriate chapter for procedures.
*DIAPHRAGM GASKET
*DIAPHRAGM
Gasket and diaphragm sequence may be reversed on some models. Head of rivet must touch inlet needle. Rivet is hooked into inlet needle control lever on some models. See appropriate chapter.
Check ball is not serviceable on some models. See appropriate chapter for specific model.
WELCH PLUG (If Present)
*MAIN NOZZLE CHECK BALL (If Present)
ATMOSPHERIC VENT HOLE
Hole must be clean. On models with bulb primer, vent hole is very small and is located off center.

* NON METALLIC ITEMS - CAN BE DAMAGED BY HARSH CARBURETOR CLEANERS

Service hints for the diaphragm carburetors

NOTE: *In rebuilding, use carburetor cleaner only on metal parts, except for the main nozzle in the main body.*

Throttle Plate

Install the throttle plate with the short line that is stamped in the plate toward the top of the carburetor, parallel with the throttle shaft, and facing out when the throttle is closed.

Choke Plate

Install the choke plate with the flat side of the choke toward the fuel inlet side of the carburetor. The mark faces in and is parallel to the choke shaft.

Idle Mixture Adjustment Screw

There is a neoprene O-ring on the needle. Never soak the O-ring in carburetor solvent. Idle and main mixture screws vary in size and design, so make sure that you have the correct replacement.

Idle Fuel Chamber

The welch plug can be removed if the carburetor is extremely dirty.

Diaphragms

Diaphragms are serviced and replaced by removing the four retaining screws from the cover. With the cover removed, the diaphragm and gasket may be serviced. Never soak the diaphragm in carburetor solvent. Replace the diaphragm if it is cracked or torn. Be sure there are no wrinkles in the diaphragm when it is replaced. The diaphragm rivet head is always placed facing the inlet needle valve.

Inlet Needle and Seat

The inlet seat is removed by using eith a slotted screwdriver (early type) or a $^{9}/_{32}$ in. socket. The inlet needle is spring loaded, so be careful when removing it.

Fuel Inlet Fitting

All of the diaphragm carburetors have an integral strainer in the inlet fitting. To clean it, either reverse flush it or use compressed air after removing the inlet needle and seat. If the strainer is lacquered or otherwise unable to be cleaned, replace the fitting.

CRAFTSMAN FUEL SYSTEMS

Changes in Late Model Carburetors

The newest Craftsman carburetors incorporate the following changes:

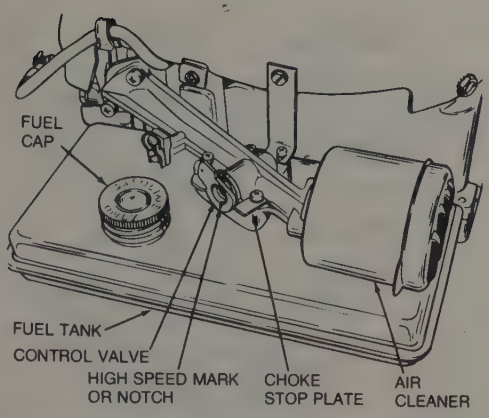
a. The cable form of control is replaced by a control knob.

b. The fuel pickup is longer and has a collar machined into it which must be installed tight against the carburetor body.

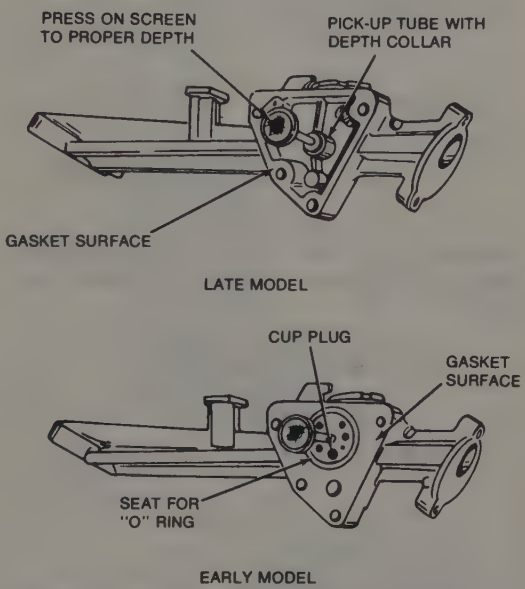
c. The fuel pickup screen is pressed onto the ends of the fill tubes on both models, but the measured depth has changed.

d. The cross-drilled passages have been eliminated, as has the O-ring on the body. There are no cup plugs.

e. The fuel tank and reservoir tube have been revised—the reservoir tube being larger.



Craftsman fuel tank mounted carburetor

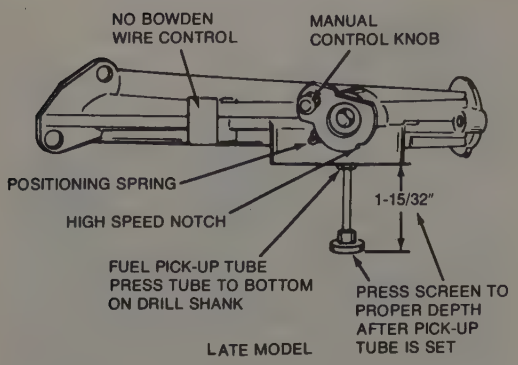


Details of pick-up tube used on revised Craftsman carburetor

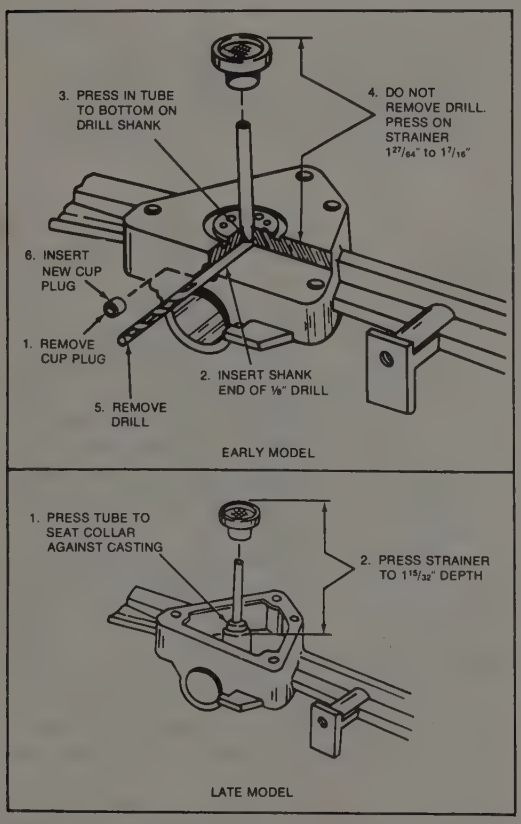
Disassembly and Service

1. Remove the air cleaner assembly and remove the four screws on the top of the carburetor body to separate the fuel tank from the carburetor.

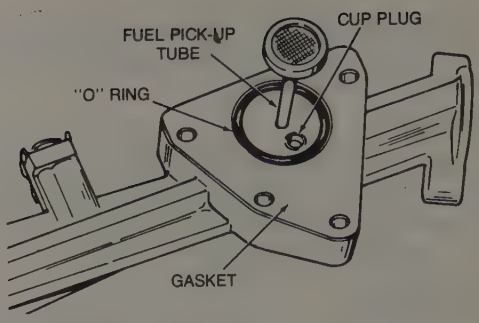
2. Remove the O-ring from between the carburetor and the fuel tank. Examine it for


NO BOWDEN WIRE CONTROL
MANUAL CONTROL KNOB
POSITIONING SPRING
HIGH SPEED NOTCH
1-15/32"
FUEL PICK-UP TUBE PRESS TUBE TO BOTTOM ON DRILL SHANK
PRESS SCREEN TO PROPER DEPTH AFTER PICK-UP TUBE IS SET
LATE MODEL
BOWDEN CONTROL
1-27/64"
FUEL PICK-UP TUBE (SET COLLAR AGAINST CASTING BODY)
PRESS SCREEN TO PROPER DEPTH AFTER PICK-UP TUBE IS SET
EARLY MODEL

Details of manual control knob and several other changes incorporated in new Craftsman carburetors


3. PRESS IN TUBE TO BOTTOM ON DRILL SHANK
4. DO NOT REMOVE DRILL. PRESS ON STRAINER 1 27/64" to 1 17/16"
6. INSERT NEW CUP PLUG
1. REMOVE CUP PLUG
2. INSERT SHANK END OF 1/8" DRILL
5. REMOVE DRILL
EARLY MODEL
1. PRESS TUBE TO SEAT COLLAR AGAINST CASTING
2. PRESS STRAINER TO 1 15/32" DEPTH
LATE MODEL

Pick-up tube replacement



Positioning of the reservoir tube in the fuel tank

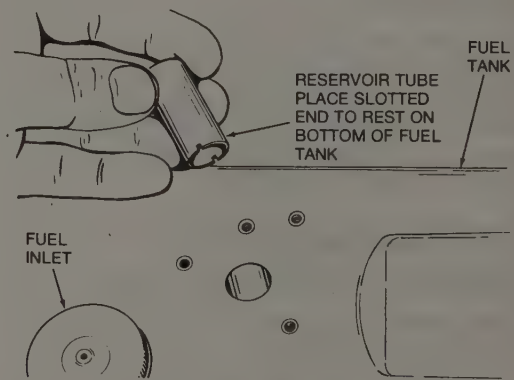
cracks and damage and replace it if necessary.

3. Carefully remove the reservoir tube from the fuel tank. Observe the end of the tube that rested on the bottom of the fuel tank. It should be slotted.

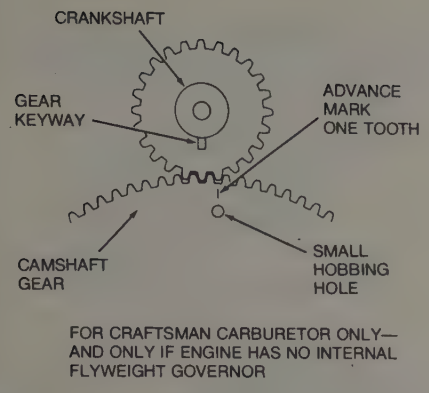
4. Remove the control valve by turning the valve clockwise until the flange is clear of the retaining boss. Pull the valve straight out and examine the O-ring seal for damage or wear. If possible, use a new O-ring when reassembling.

5. Examine the fuel pick up tube. There are no valves or ball checks that may become inoperative. These parts can normally be cleaned with carburetor solvent. If it is found that the passage cannot be cleared, the fuel pick up tubes can be replaced. Carefully remove the old ones so as not to enlarge the opening in the carburetor body. If the pickup tube and screen must be replaced, follow the directions shown in the illustration for the type of carburetor (early or late model) on which you are working.

6. Assemble the carburetor in reverse order of disassembly. Use new O-rings and gaskets. When assembling reservoir tube, hold the carburetor upside down and place the reservoir tube over the pickup tube with the slotted end up. Make sure the intake manifold



The fuel pick-up tube and O-ring on the early model Craftsman carburetor


CRANKSHAFT
GEAR KEYWAY
ADVANCE MARK ONE TOOTH
CAMSHAFT GEAR
SMALL HOBBING HOLE
FOR CRAFTSMAN CARBURETOR ONLY—AND ONLY IF ENGINE HAS NO INTERNAL FLYWEIGHT GOVERNOR

Timing an engine with the Craftsman fuel tank mounted carburetor

gasket is correctly positioned—it can be assembled blocking the intake passage partially.

Adjustments

1. Move the carburetor control valve to the high speed position. The mark on the face of the valve should be in alignment with the retaining boss on the carburetor body.
2. Move the operator's control on the equipment to the high speed position.
3. Insert the bowden wire into the hole of the control valve. Clamp the bowden wire sheath to the carburetor body.

NOTE: *If the engine was disassembled and the camshaft removed, be sure that the timing marks on the camshaft gear and the keyway in the crankshaft gear are aligned when reinserting the camshaft. Then lift the camshaft enough to advance the camshaft gear timing mark to the right (clockwise) ONE tooth, as viewed from the power take-off end of the crankshaft.*

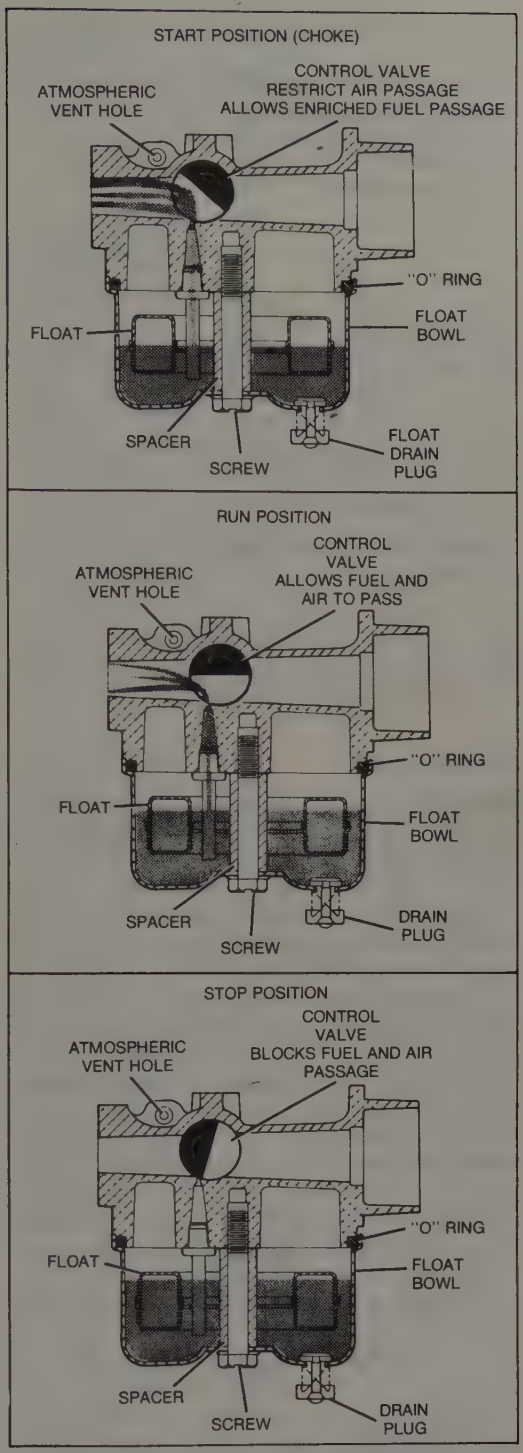
CRAFTSMAN FLOAT TYPE CARBURETORS

Craftsman float type carburetors are serviced in the same manner as the other Tecumseh float type carburetors. The throttle control valve has three positions: stop, run, and start.

When the control valve is removed, replace the O-ring. If the engine runs sluggishly, consider the possibility of a leaky O-ring.

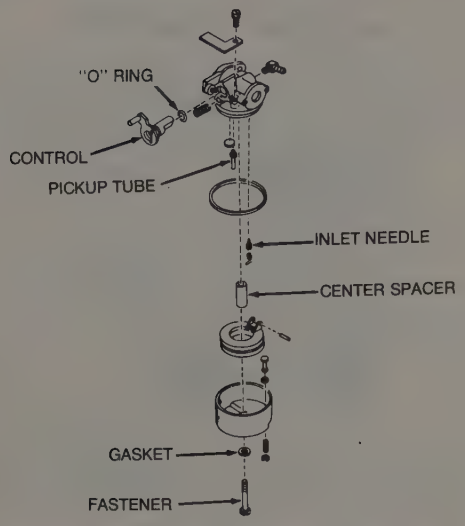
To remove the fuel pickup tube, clamp the tube in a vise and then twist the carburetor body. Check the small jet in the air horn while the tube is out. In replacement, position the tube squarely and then press in on the collar until the collar seats.

In assembly, install the gasket and bolt through the bowl, position the centering spacer onto the bolt, and then attach the parts to the carburetor body.



Start, run and stop throttle positions of a Craftsman float type carburetor

The camshaft timing mark must be advanced one tooth in relation to crankshaft gear timing mark, as shown in the illustration above. However, when this type carburetor is used with a float bowl reservoir and variable gov-



Exploded view of the Craftsman float type carburetor

ernor adjustment, time it as for other Tecumseh engines—with the camshaft and crankshaft timing marks aligned.

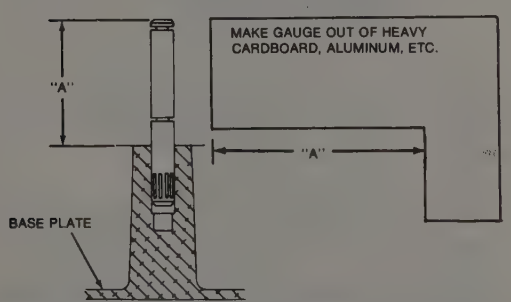
Governor

The mechanical governor is located inside the mounting flange. See engine disassembly instructions, below. To disassemble the governor, see the illustration, and: remove the retaining ring, pull off the spool, remove the second retaining ring, and then pull off the gear assembly and retainer washer.

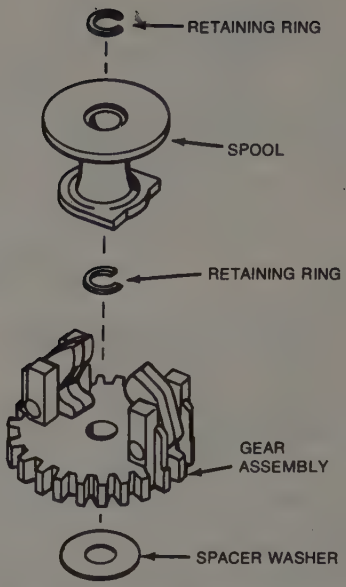
Check for wear on all moving surfaces, but especially gear teeth, the inside diameter of the gear where it rides on the shaft, and the flyweights where they work against the spool.

If the governor shaft must be replaced, it should be started into the boss with a few taps using a soft hammer, and then pressed in with a press or vise. The shaft *can* be installed by positioning a wooden block on top and tapping the upper surface of the block, but the use of a vise or press is much preferred.

The shaft must be pressed in until just the required length is exposed, as measured from the top of the shaft boss to the upper end of the shaft. See the chart.



Measuring governor shaft installed dimension



Exploded view of standard mechanical governor

The governor is installed in reverse of the removal procedure. Connect the linkage and then adjust as described in the Tune-Up section.

Shaft Installed Dimension/ Engine Model Chart

Engine Model	"A" Exposed Shaft Length (see figure)
LAV30-50 H25-35 HS40-50	$1^{5}/_{16}$"
V50	$1^{19}/_{32}$"
H50 HH40	$1^{7}/_{16}$"

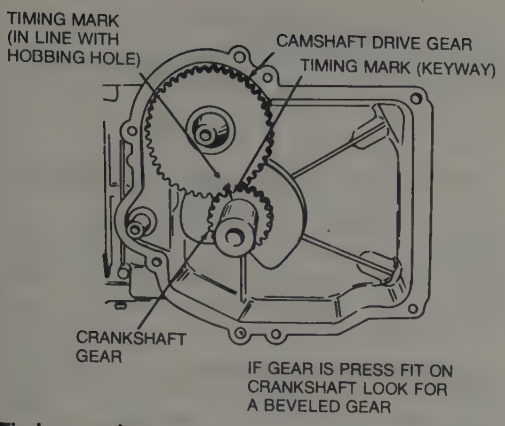
ENGINE OVERHAUL

Timing Gears

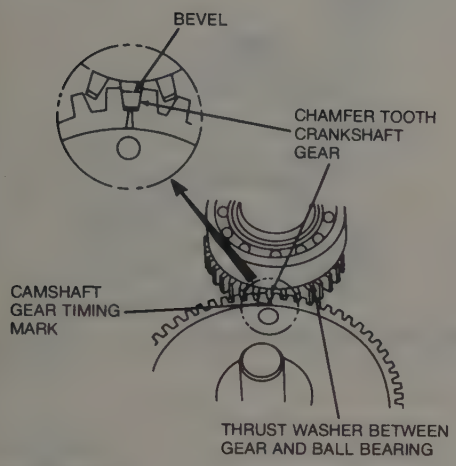
Correctly matched camshaft gear and crankshaft gear timing marks are necessary for the engine to perform properly.

On all camshafts the timing mark is located in line with the center of the hobbing hole (small hole in the face of the gear). If no line is visible, use the center of the hobbing hole to align with the crankshaft gear marked tooth.

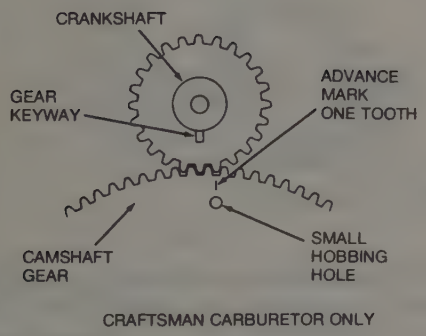
On crankshafts where the gear is held on by a key, the timing mark is the tooth in line with the keyway.


TIMING MARK (IN LINE WITH HOBBING HOLE)
CAMSHAFT DRIVE GEAR
TIMING MARK (KEYWAY)
CRANKSHAFT GEAR
IF GEAR IS PRESS FIT ON CRANKSHAFT LOOK FOR A BEVELED GEAR

Timing marks



Timing marks



Timing marks

On crankshafts where the gear is pressed onto the crankshaft, a tooth is bevelled to serve as the timing mark.

On engines with a ball bearing on the power take-off end of the crankshaft, look for a bevelled tooth which serves as the crankshaft gear timing mark.

If the engine uses a Craftsman type carburetor, the camshaft timing mark must be advanced clockwise one tooth ahead of the matching timing mark on the crankshaft, the exception being the Craftsman variable governed fuel systems.

NOTE: *If one of the timing gears, either the crankshaft gear or the camshaft gear, is damaged and has to be replaced, both gears should be replaced.*

Crankshaft

INSPECTION

Inspect the crankshaft for worn or crossed threads that can't be redressed; worn, scratched, or damaged bearing surfaces; misalignments; flats on the bearing surfaces. Replace the shaft if any of these problems are in evidence—do not try to straighten a bent shaft.

In replacement, be sure to lubricate the bearing surfaces and use oil seal protectors. If the camshaft gear requires replacement, replace the crankshaft gear, also.

LAV35-LAV50 and H35-HS50 crankshafts have a press fit gear. If the camshaft gear requires replacement on these engines, the crankshaft must be replaced, as the gear cannot be replaced separately.

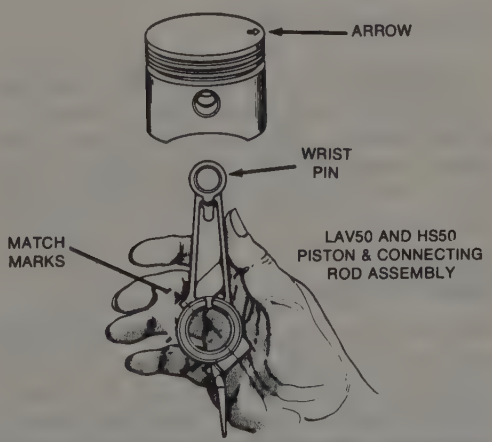
Pistons

When removing the pistons, clean the carbon from the upper cylinder bore and head. The piston and pin must be replaced in matched pairs.

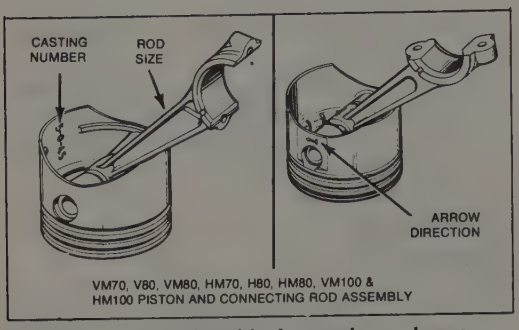
A ridge reamer must be used to remove the ridge at the top of the cylinder bore on some engines.

Clean the carbon from the piston ring groove. A broken ring can be used for this operation.

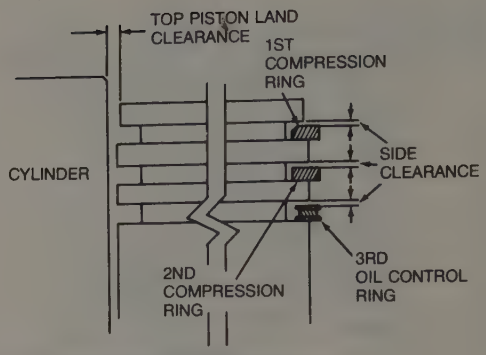
Some engines have oversize pistons which can be identified by the oversize engraved on the piston top.



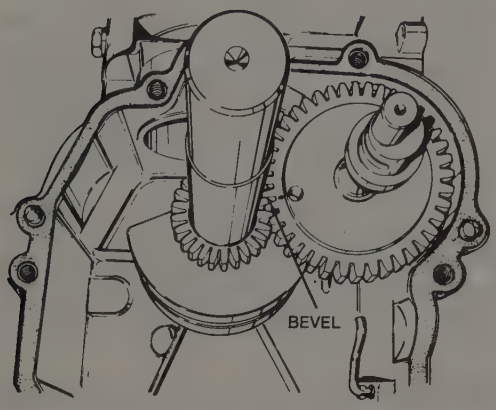
Piston-to-rod relationship for LAV50 and HS50 engines



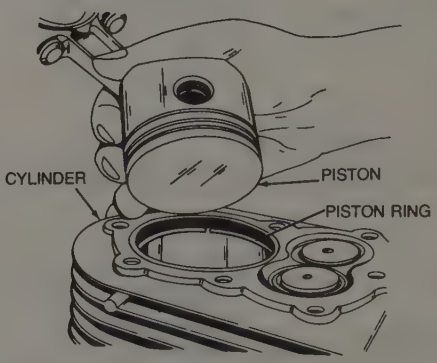
Piston-to-rod relationship for engines shown



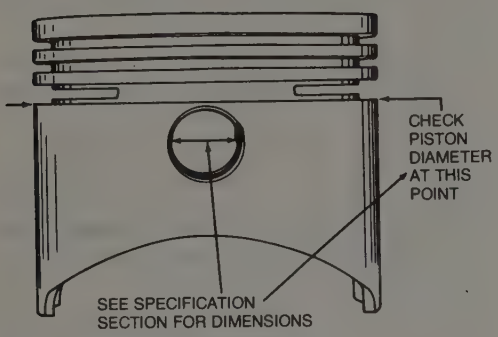
Ring arrangement and dimensions



Timing marks for the LAV40 and HS40 engines



Squaring the ring in the bore



Check piston dimensions

Checking the ring gap

There is a definite piston-to-connecting rod-to-crankshaft arrangement which must be maintained when assembling these parts. If the piston is assembled in the bore 180° out of position, it will cause immediate binding of the parts.

Piston Rings

Always replace the piston rings in sets. Ring gaps must be staggered. When using new rings, wipe the cylinder wall with fine emery cloth to deglaze the wall. Make sure the cylinder wall is thoroughly cleaned after deglazing. Check the ring gap by placing the ring squarely in the center of the area in which the rings travel and measuring the gap with a feeler gauge. Do not spread the rings too wide when assembling them to the pistons. Use a ring leader to install the rings on the piston.

The top compression ring has an inside chamfer. This chamfer must go UP. If the second ring has a chamfer, it must also face UP. If there is a notch on the outside diameter of the ring, it must face DOWN.

Check the ring gap on the old ring to determine if the ring should be replaced. Check the ring gap on the new ring to determine if the cylinder should be rebored to take oversize parts.

NOTE: *Make sure that the ring gap is mea-*

sured with the ring fitted squarely in the worn part of the cylinder where the ring usually rides up and down on the piston.

Connecting Rods

Be sure that the match marks align when assembling the connecting rods to the crankshaft. Use new self-locking nuts. Whenever locking tabs are included, be sure that the tabs lock the nuts securely. NEVER try to straighten a bent crankshaft or connecting rod. Replace them if necessary. When replacing either the piston, rod, crankshaft, or camshaft, liberally lubricate all bearings with engine oil before assembly.

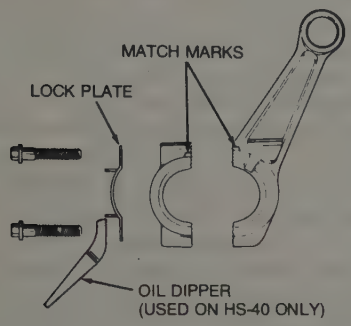
The following engines have offset connecting rods: LAV40, LAV50, HS40, HS50. The LAV40, LAV50, HS40, HS50 engines have the caps fitted from opposite to the camshaft side of the engine.

On engine with Durlock rod bolts, torque the bolts as follows:

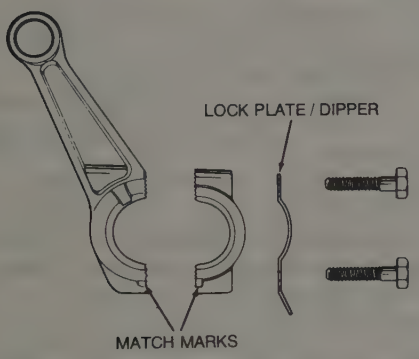
LAV25–50, H25, 35, HS40–50, 110 in. lbs.
V50, H50, VH50, HH50, 150 in. lbs.

NOTE: *Early type caps can be distorted if the cap is not held to the crank pin while threading the bolts tight. Undue force should not be used.*

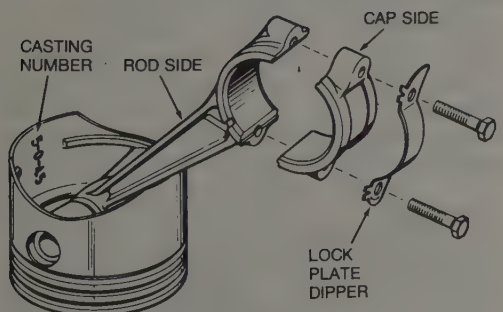
Later rods have serrations which prevent distortion during tightening. They also have match marks which must face out when assembling the rod. On the LAV50 and the HS50 engines, the piston must be fitted to the rod with the arrow on the top of the piston pointing to the right and the match marks on the rod facing you when the piston is pinned to the rod.



Connecting rod assembly for the LAV40 and HS40 engine



Connecting rod assembly for the V70, V80, H70 and H80 engines



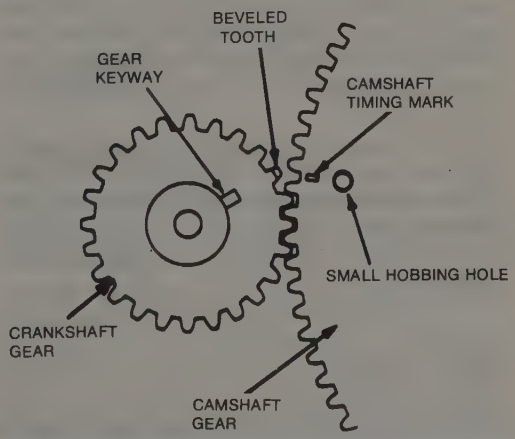
Connecting rod and piston assembly for the V80 and H80 engines

Camshaft

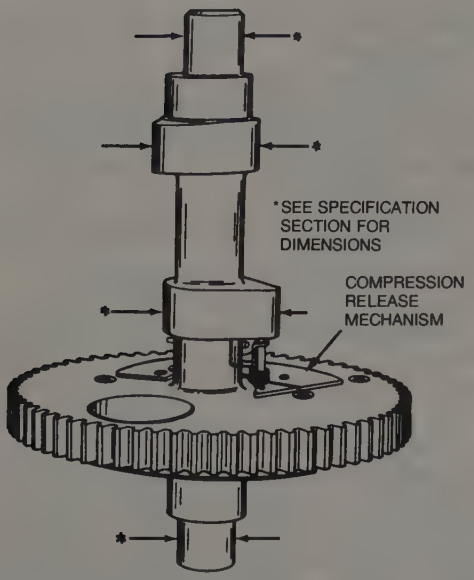
Before removing the camshaft, align the timing marks to relieve the pressure on the valve lifters, on most engines.

In installation, align the gears for this type of camshaft as they were right before removal. After installation, turn the crankshaft gear clockwise in order to check for proper alignment of timing marks.

Clean the camshaft in solvent, then blow the oil passages dry with compressed air. Replace the camshaft if it shows wear of evidence of scoring. Check the cam dimensions against those in the chart.



Alignment of timing marks for camshaft removal on VM80 and VM100 engines



Check the dimensions of the camshaft

If the engine has a mechanical fuel pump, it may have to be removed to properly reinstall the camshaft. If the engine is equipped with the Insta-matic Ezee-Start Compression Release, and any of the parts have to be replaced due to wear or damage, the entire camshaft must be replaced. Be sure that the oil pump (if so equipped) barrel chamber is toward the fillet of the camshaft gear when assembled.

NOTE: *If a damaged gear is replaced, the crankshaft gear should also be replaced.*

Valve Springs

The valve springs should be replaced whenever an engine is overhauled. Check the free length of the springs. Comparing one spring with the other can be a quick check to notice any differences. If a difference is noticed, carefully measure the free length, compression length, and strength of each spring. See the specifications chart at the end of this section.

Some valve springs use dampening coils—coils that are wound closer together than most of the coils of the spring. Where these are present, the spring must be mounted so the dampening coils are on the stationary (upper) end of the spring.

Valve Lifters

The stems of the valves serve as the lifters. On the 4 hp light frame models, the lifter stems are of different lengths. Because this engine is a cross port model, the shorter intake valve lifter goes nearest the mounting flange.

The valve lifters are identical on standard port engines. However once a wear pattern is established, they should not be interchanged.

Valve Grinding and Replacement

Valves and valve seats can be removed and reground with a minimum of engine disassembly.

Remove the valves as follows:

1. Raise the lower valve spring caps while holding the valve heads tightly against the valve seat to remove the valve spring retaining pin. This is best achieved by using a valve spring compressor. Remove the valves, springs, and caps from the crankcase.

2. Clean all parts with a solvent and remove all carbon from the valves.

3. Replace distorted or damaged valves. If the valves are in usable condition, grind the valve faces in a valve refacing machine and to the angle given in the specifications chart at the end of this section. Replace the valves if the faces are ground to less than 1/32 in.

4. Whenever new or reground valves are installed, lap in the valves with lapping compound to insure an air-tight fit.

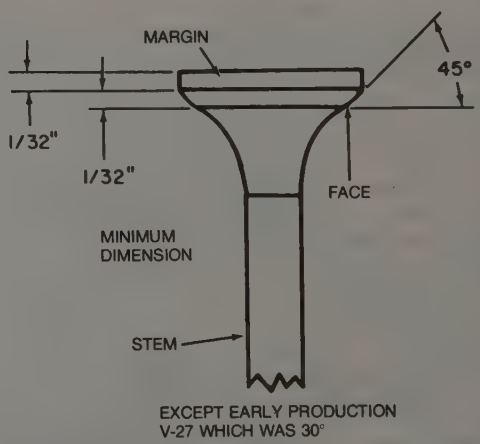
NOTE: *There are valves available with oversize stems.*

5. Valve grinding changes the valve lifter clearance. After grinding the valves check the valve lifter clearance as follows:

a. Rotate the crankshaft until the piston is set at the TDC position of the compression stroke.

b. Insert the valves in their guides and hold the valves firmly on their seats.

c. Check for a clearance of 0.010 in. between each valve stem and valve lifter with a feeler gauge.



Dimensions of the valve face

d. Grind the valve stem in a valve resurfacing machine set to grind a perfectly square face with the proper clearance.

6. Install valves as follows on Early Models:

a. Position the valve spring and upper and lower valve spring caps under the valve guides for the valve to be installed.

b. Install the valves in the guides, making sure that the valve marked "EX" is inserted in the exhaust port. The valve stem must pass through the valve spring and the valve spring caps.

c. Insert the blade of a screwdriver under the lower valve spring cap and pry the spring up.

d. Insert the valve pin through the hole in the valve stem with a long nosed pliers. Make sure the valve pin is properly seated under the lower valve spring cap.

Install the valves as follows on Later Models:

a. Position the valve caps and spring in the valve compartment.

b. Install the valves in guides with the valve marked "EX" in exhaust port. The valve stem must pass through the upper valve cap and spring. The lower cap should sit around the valve lifter exposed end.

c. Compress the valve spring so that the shank is exposed. DO NOT TRY TO LIFT THE LOWER CAP WITH THE SPRING.

d. Lift the lower valve cap over the valve stem shank and center the cap in the smaller diameter hole.

e. Release the valve spring tension to lock the cap in place.

REBORING THE CYLINDER

1. First, decide whether to rebore for 0.010 in. or 0.020 in.

2. Use any standard commercial hone of suitable size. Chuck the hone in the drill press with the spindle speed of about 600 rpm.

3. Start with coarse stones and center the cylinder under the press spindle. Lower the hone so the lower end of the stones contact the lowest point in the cylinder bore.

4. Rotate the adjusting nut so that the stones touch the cylinder wall and then begin honing at the bottom of the cylinder. Move the hone up and down at a rate of 50 strokes a minute to avoid cutting ridges in the cylinder wall. Every fourth or fifth stroke, move the hone far enough to extend the stones 1 in. beyond the top and bottom of the cylinder bore.

5. Check the bore size and straightness every thirty or forty strokes. If the stones collect metal, clean them with a wire brush each time the hone is removed.

6. Hone with coarse stones until the cylinder bore is within 0.002 in. of the desired finish size. Replace the coarse stones with burnishing stones and continue until the bore is to within 0.0005 in. of the desired size.

7. Remove the burnishing stones and install finishing stones to polish the cylinder to the final size.

8. Clean the cylinder with solvent and dry it thoroughly.

9. Replace the piston and piston rings with the correct oversize parts.

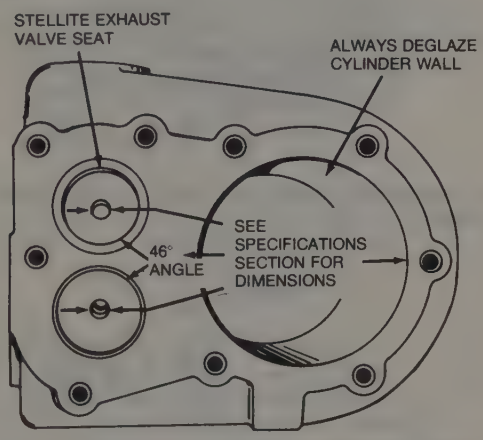
REBORING VALVE GUIDES

The valve guides are permanently installed in the cylinder. However, if the guides wear, they can be rebored to accommodate a $^{1}/_{32}$ in. oversize valve stem. Rebore the valve guides in the following manner:

1. Ream the valve guides with a standard straight shanked hand reamer or a low speed drill press. Refer to the specifications chart at the end of this section for the correct valve stem guide diameter.

2. Redrill the upper and lower valve spring caps to accommodate the oversize valve stem.

3. Reassemble the engine, installing valves with the correct oversize stems in the valve guides.



Check the dimensions of the valve seats, guides, and the cylinder

REGRINDING VALVE SEATS

The valve seats need regrinding only if they are pitted or scored. If there are no pits or scores, lapping in the valves will provide a proper valve seat. Valve seats are not replaceable. Regrind the valve seats as follows:

1. Use a grinding stone or a reseater set to provide the proper angle and seal face dimensions.

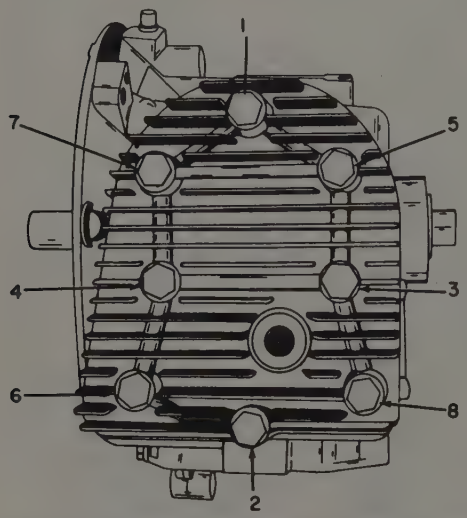
2. If the seat is over $^{3}/_{64}$ in. wide after grinding, use a 15° stone or cutter to narrow the face to the proper dimensions.

3. Inspect the seats to make sure that the cutter or stone has been held squarely to the valve seat and that the same dimension has been held around the entire circumference of the seat.

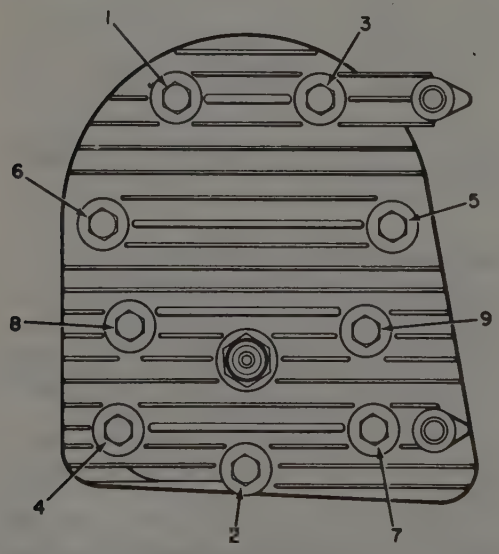
4. Lap the valves to the reground seats.

Torquing Cylinder Head

Torque the cylinder head to 200 in. lbs in 4 equal stages of 50 in. lbs. Follow the sequence shown in the appropriate illustration for each tightening stage.



Cylinder head tightening sequence for all engines except 8 hp models



Cylinder head tightening sequence for 8 hp models

Bearing Service

LIGHTWEIGHT ALUMINUM BEARING REPLACEMENT

The aluminum bearing must be cut out using the rough cut reamer and the procedures shown in steps 1A and 4A. Follow illustrated steps 1A, 2, 3, 4A, 5 and 6 to install bronze bushings in place of the aluminum bearings.

LONG LIFE AND CAST IRON ENGINES WITHOUT BALL BEARINGS

The worn bronze bushing must be driven out before the new bushing can be installed. Follow illustrated steps 1B, 2, 3, 4B, 5 and 6, to replace the main bearings on these units.

LONG LIFE AND CAST IRON ENGINES WITH BALL BEARING ON THE P.T.O. (POWER TAKE-OFF) SIDE OF THE CRANKSHAFT

The side cover containing the ball bearing must be removed and a substitute cover with either a new bronze bushing or aluminum bearing must be used instead. Follow illustrated steps 1B, 2 and 3 only.

SPECIAL TOOLS

The task of main bearing replacement is made easier by using one of two Tecumseh main bearing tool kits. Kit 670161 is used to replace main bearings on the lightweight engines except HS, LAV40 and 50 models. Kit 670165 is used to replace main bearings on the medium weight engines except HS, LAV40 and 50 models.

GENERAL NOTES ON BUSHING REPLACEMENT

1. Your fingers and all parts must be kept very clean when replacing bushings.

2. On splash lubricated horizontal engines, the oil hole in the bushing is to be lined up with the oil hole that leads into the slot in the original bearing.

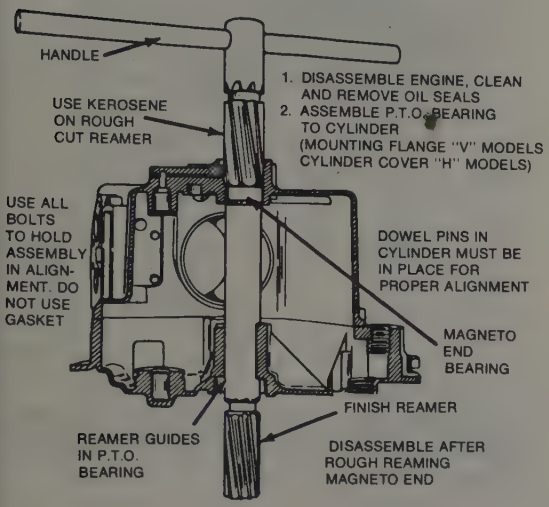
3. In the event it is necessary to replace the mounting flange or cylinder cover, the magneto end bearing must be rebushed. The P.T.O. bearing should also be rebushed to assure proper alignment.

4. Oil should be used to finish—ream the bushings. In the event the crankshaft does not rotate freely repeat the finish—reaming operation without oil.

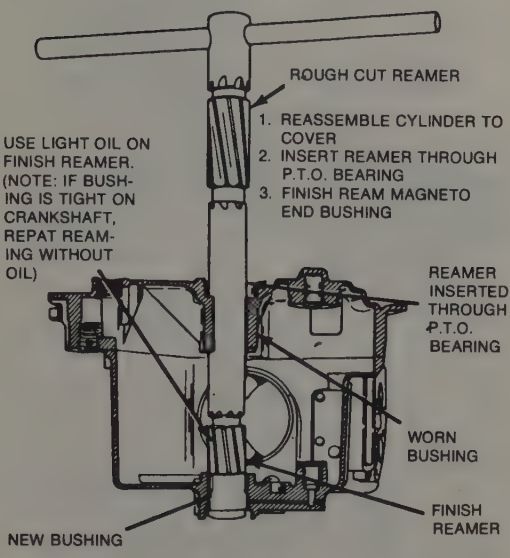
5. Kerosene should be used as a cutting lubricant while rough—reaming.

6. Be sure that the dowel pins are in the cylinder block when assembling the mounting flange or cylinder cover. Use all bolts to hold the assembly together.

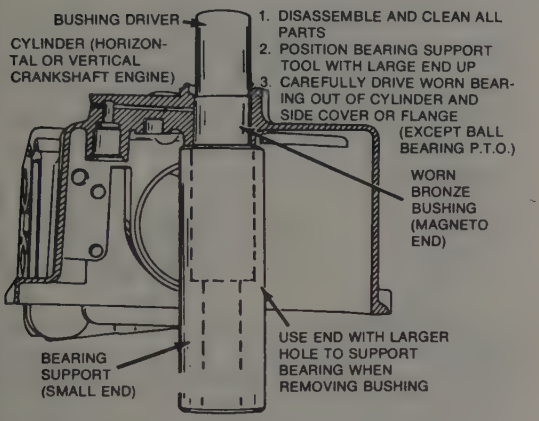
ROUGH REAMING WORN ALUMINUM BEARING (MAGNETO SIDE) FOR ALUMINUM BEARING ONLY


HANDLE
USE KEROSENE ON ROUGH CUT REAMER
1. DISASSEMBLE ENGINE, CLEAN AND REMOVE OIL SEALS
2. ASSEMBLE P.T.O. BEARING TO CYLINDER (MOUNTING FLANGE "V" MODELS CYLINDER COVER "H" MODELS)
USE ALL BOLTS TO HOLD ASSEMBLY IN ALIGNMENT. DO NOT USE GASKET
DOWEL PINS IN CYLINDER MUST BE IN PLACE FOR PROPER ALIGNMENT
MAGNETO END BEARING
FINISH REAMER
REAMER GUIDES IN P.T.O. BEARING
DISASSEMBLE AFTER ROUGH REAMING MAGNETO END

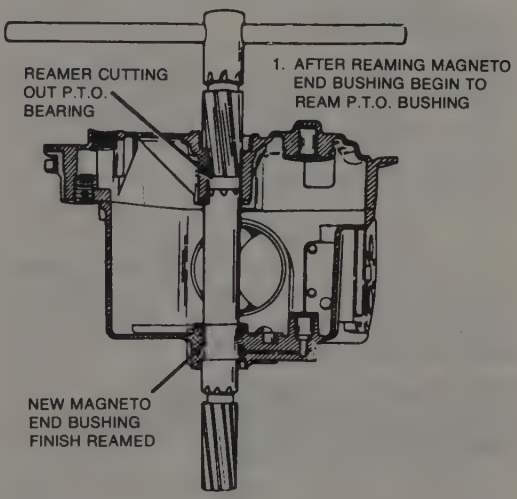
FINISH REAMING NEW MAGNETO BUSHING


ROUGH CUT REAMER
1. REASSEMBLE CYLINDER TO COVER
2. INSERT REAMER THROUGH P.T.O. BEARING
3. FINISH REAM MAGNETO END BUSHING
USE LIGHT OIL ON FINISH REAMER. (NOTE: IF BUSHING IS TIGHT ON CRANKSHAFT, REPAT REAMING WITHOUT OIL)
REAMER INSERTED THROUGH P.T.O. BEARING
WORN BUSHING
FINISH REAMER
NEW BUSHING

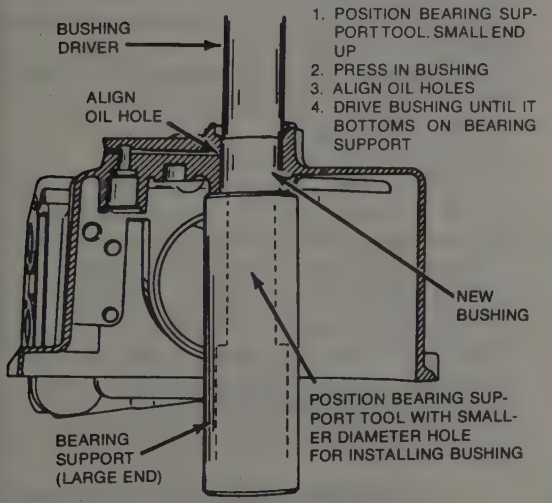
WORN BUSHING REMOVAL (MAGNETO END) FOR BRONZE BUSHING ONLY


BUSHING DRIVER
CYLINDER (HORIZONTAL OR VERTICAL CRANKSHAFT ENGINE)
1. DISASSEMBLE AND CLEAN ALL PARTS
2. POSITION BEARING SUPPORT TOOL WITH LARGE END UP
3. CAREFULLY DRIVE WORN BEARING OUT OF CYLINDER AND SIDE COVER OR FLANGE (EXCEPT BALL BEARING P.T.O.)
WORN BRONZE BUSHING (MAGNETO END)
USE END WITH LARGER HOLE TO SUPPORT BEARING WHEN REMOVING BUSHING
BEARING SUPPORT (SMALL END)

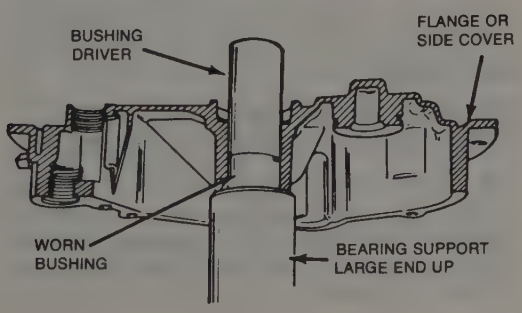
ROUGH REAMING WORN ALUMINUM BEARING (P.T.O. END) FOR ALUMINUM BEARING ONLY

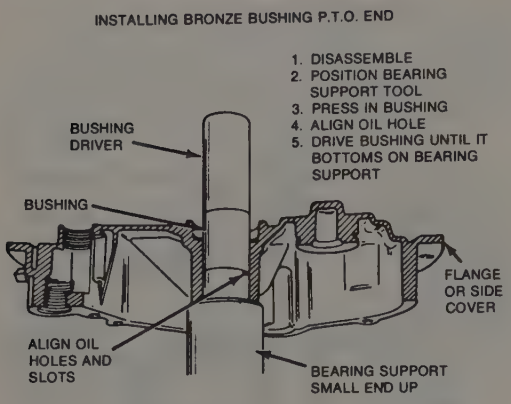

REAMER CUTTING OUT P.T.O. BEARING
1. AFTER REAMING MAGNETO END BUSHING BEGIN TO REAM P.T.O. BUSHING
NEW MAGNETO END BUSHING FINISH REAMED

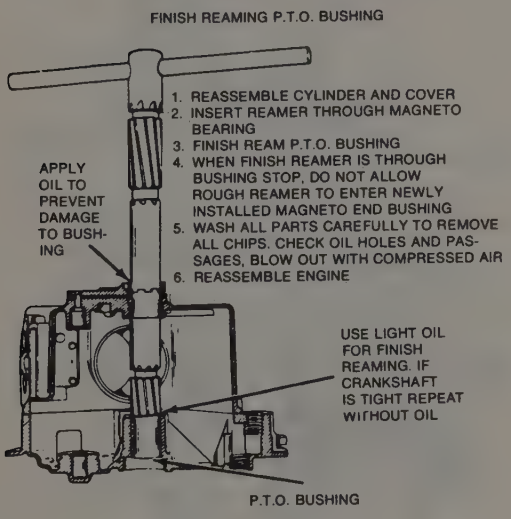
INSTALLING NEW BRONZE BUSHING (MAGNETO SIDE)


BUSHING DRIVER
ALIGN OIL HOLE
1. POSITION BEARING SUPPORT TOOL. SMALL END UP
2. PRESS IN BUSHING
3. ALIGN OIL HOLES
4. DRIVE BUSHING UNTIL IT BOTTOMS ON BEARING SUPPORT
NEW BUSHING
POSITION BEARING SUPPORT TOOL WITH SMALLER DIAMETER HOLE FOR INSTALLING BUSHING
BEARING SUPPORT (LARGE END)

WORN BUSHING REMOVAL (P.T.O. END) FOR BRONZE BUSHING ONLY




INSTALLING BRONZE BUSHING P.T.O. END
1. DISASSEMBLE
2. POSITION BEARING SUPPORT TOOL
3. PRESS IN BUSHING
4. ALIGN OIL HOLE
5. DRIVE BUSHING UNTIL IT BOTTOMS ON BEARING SUPPORT
BUSHING DRIVER
BUSHING
FLANGE OR SIDE COVER
ALIGN OIL HOLES AND SLOTS
BEARING SUPPORT SMALL END UP


FINISH REAMING P.T.O. BUSHING
1. REASSEMBLE CYLINDER AND COVER
2. INSERT REAMER THROUGH MAGNETO BEARING
3. FINISH REAM P.T.O. BUSHING
4. WHEN FINISH REAMER IS THROUGH BUSHING STOP, DO NOT ALLOW ROUGH REAMER TO ENTER NEWLY INSTALLED MAGNETO END BUSHING
5. WASH ALL PARTS CAREFULLY TO REMOVE ALL CHIPS. CHECK OIL HOLES AND PASSAGES, BLOW OUT WITH COMPRESSED AIR
6. REASSEMBLE ENGINE
APPLY OIL TO PREVENT DAMAGE TO BUSHING
USE LIGHT OIL FOR FINISH REAMING. IF CRANKSHAFT IS TIGHT REPEAT WITHOUT OIL
P.T.O. BUSHING

7. Remove the reamer by rotating it in the same direction as it is turned during the reaming operation. DO NOT TURN THE REAMER BACKWARDS.

BALL BEARING SERVICE–H20 THROUGH HS50 H.P. HORIZONTAL CRANKSHAFT ENGINES

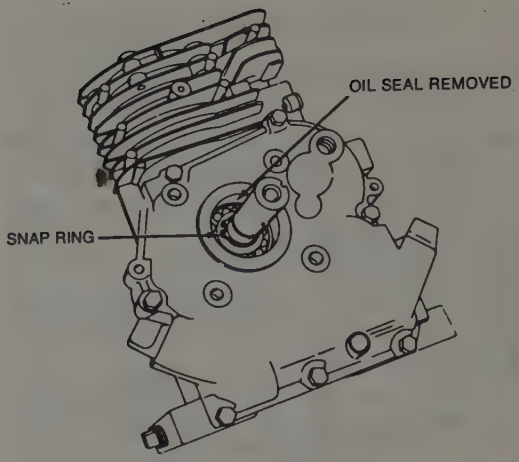
1. Remove the crankshaft P.T.O. end oil seal. Drive an awl or similar tool into the metal seal body and pry out.

2. Use snap ring pliers to remove the snap ring.

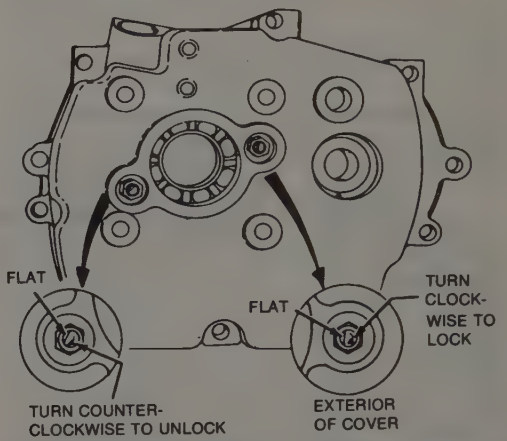
3. Reassembly is in reverse order. Secure the cylinder cover, install the snap ring and oil seal. Protect the oil seal to prevent damage during installation.

BALL BEARING SERVICE–H40, 50 HORIZONTAL CRANKSHAFT ENGINES

1. Prior to attempting removal of the cylinder cover, observe the area around the crankshaft P.T.O. oil seal. Compare it with the illustration, and if there are bearing locks, follow instructions below:



On H20-HS50 H.P. horizontal crankshaft engines, remove the oil seal and snap ring to remove the cylinder cover



H40-HM100 H.P. horizontal crankshaft engines —locking and unlocking the bearing from outside

a. Remove the locking nuts using the proper socket wrench. Note fiber washer located under nut; this must be reinstalled. Lift side cover from cylinder after removing the side cover bolts.

b. Install the bearing retainer bolts, fiber washer and locking nuts in the proper sequence in the cover.

2. Also note the following points:

A. On some engines, a locking type retainer bolt is used. To release the bolt, merely loosen the locking nut and turn the retainer bolt counterclockwise to the unlocked position with needle nose pliers to permit the side cover to be removed. Note that the flats on the retainer bolts must be turned so they face the crankshaft to be relocked upon installation. Don't force them! Torque the locking nuts only to 15–22 in. lbs.

B. The ball bearing used in horizontal

crankshaft engines has a restricted fit. The bearing is heated and put onto the cold crankshaft. As the bearing cools it grasps the crankshaft tightly and must be removed cold. Remove the ball bearing with a bearing splitter (separator) and a puller. The bearing may be heated by placing it into a container with a sufficient amount of oil to cover the bearing. The bearing should not rest on the bottom of the container. Suspend the bearing on a wire or set the bearing onto a spacer block of wood or wire mesh. Heat the oil and bearing carefully until the oil smokes, quickly remove the bearing and slide it onto the crankshaft.

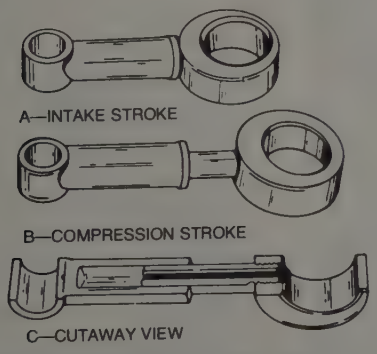
C. The bearing must seat tightly against the thrust washer which in turn rests tightly against the crankshaft gear.

D. When a ball bearing is used it is not possible to see the keyway in the crankshaft gear which is normally used for timing. Because of this, one tooth of the crankshaft gear is chamfered. This chamfered tooth of the crankshaft gear is positioned opposite the timing mark on the camshaft gear. The use of a ball bearing requires the removal of the crankshaft when it is necessary to remove the camshaft. When replacing the crankshaft and camshaft, mate the timing marks and insert it into the cylinder block as an assembly.

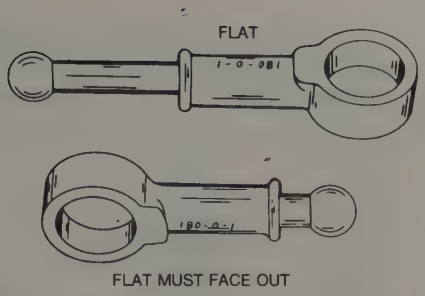
LUBRICATION

Barrel and Plunger Oil Pump System

This system is driven by an eccentric on the camshaft. Oil is drawn through the hollow camshaft from the oil sump on its intake stroke. The passage from the sump through the camshaft is aligned with the pump opening. As the camshaft continues rotation (pressure stroke), the plunger force the oil out. The other port in the camshaft is aligned with the pump,



Operation of the barrel type oil pump



Installation of the barrel type oil pump

and directs oil out of the top of the camshaft.

At the top of the camshaft, oil is forced through a crankshaft passage to the top main bearing groove which is aligned with the drilled crankshaft passage. Oil is directed through this passage to the crankshaft connecting rod journal and then spills from the connecting rod to lubricate the cylinder walls. Splash is used to lubricate the other parts of the engine.

A pressure relief port in the crankcase relieves excessive pressures when the oil viscosity is extremely heavy due to cold temperatures, or when the system is plugged or damaged. Normal pressure is 7 psi.

SERVICE

Remove the mounting flange or the cylinder cover, whichever is applicable. Remove the barrel and plunger assembly and separate the parts.

Clean the pump parts in solvent and inspect the pump plunger and barrel for rough spots or wear. If the pump plunger is scored or worn, replace the entire pump.

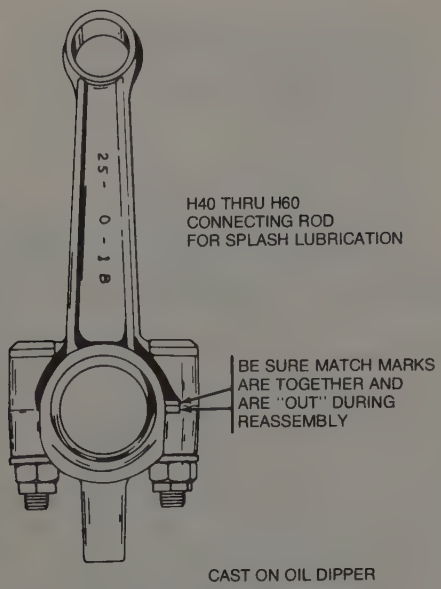
Before reassembling the pump parts, lubricate all of the parts in engine oil. Manually operate the pump to make sure the plunger slides freely in the barrel.

Lubricate all the parts and position the barrel on the camshaft eccentric. If the oil pump has a chamfer only on one side, that side must be placed toward the camshaft gear. The flat goes away from the gear, thus out to work against the flange oil pickup hole.

Install the mounting flange. Be sure the plunger ball seats in the recess in the flange before fastening it to the cylinder.

SPRAY MIST LUBRICATION

Late model LAV40, LAV30, and LAV35 engines have a spray mist lubrication system. This system is the same as the barrel and plunger oil pump system except that (1) the pressure relief port is changed to a calibrated spray mist orifice and (2) the crankshaft is not rifle-drilled from the top main to the crank pin. Lubrication is sprayed to the narrow rod cap area through the spray mist hole.



Splash type lubrication connecting rod

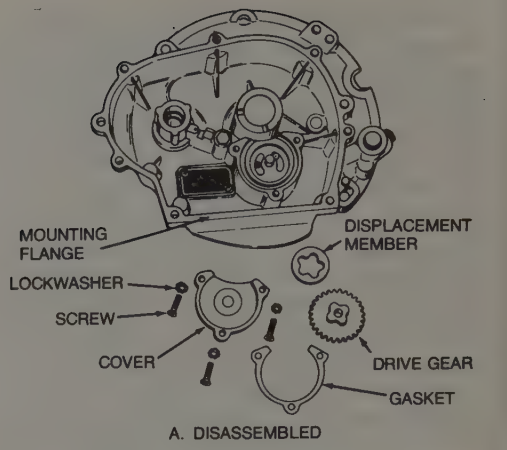
SPLASH LUBRICATION

Some engines utilize the splash type lubrication system. The oil dipper, on some engines, is cast onto the lower connecting rod bearing cap. It is important that the proper parts are used to ensure the longest engine life.

GEAR TYPE OIL PUMP SYSTEM

The gear type lubrication pump is a crankshaft driven, positive displacement pump. It pumps oil from the oil sump in the engine base to the camshaft, through the drilled camshaft passage to the top main bearing, through the drilled crankshaft, to the connecting rod journal on the crankshaft.

Spillage from the connecting rod lubricates the cylinder walls and normal splash lubricates the other internal working parts. There is a pressure relief valve in the system.



Disassembled view of the gear type lubrication system

Service

Disassemble the pump as follows: remove the screws, lockwashers, cover, gear, and displacement member.

Wash all of the parts in solvent. Inspect the oil pump drive gear and displacement member for worn or broken teeth, scoring, or other damage. Inspect the shaft hole in the drive gear for wear. Replace the entire pump if cracks, wear, or scoring is evident.

To replace the oil pump, position the oil pump displacement member and oil pump gear on the shaft, then flood all the parts with oil for priming during the initial starting of the engine.

The gasket provides clearance for the drive gear. With a feeler gauge, determine the clearance between the cover and the oil pump gear. The clearance desired is 0.006 to 0.007 in. Use gaskets, which are available in a variety of sizes, to obtain the correct clearance. Position the oil pump cover and secure it with the screws and lockwashers.

Craftsman Engines Cross Reference Chart

Craftsman Engine Models	See Column
143.50040	7
143.50045	
143.131022–143.131102	1
143.135012–143.135112	9
143.137012	7
143.137032	
143.141012–143.143032	1
143.145012–143.145072	9
143.146022	
143.146022	
143.147012–143.147032	7
143.151012–143.153032	1
143.154012–143.154142	2
143.155012–143.155062	9
143.156022	
143.157012–143.157032	7
143.161012–143.163062	1
143.164012–143.164202	2
143.165012–143.165052	9
143.167012–143.167042	7
143.171012–143.171172	1
143.171202	2
143.171212–143.173042	1
143.174012–143.174292	2
143.175012–143.175072	9
143.177012–143.177072	7
143.181042–143.183042	1
143.184012–143.184212	2
143.184232–143.184252	4
143.184262–143.184402	2
143.185012–143.185052	9
143.186062	
143.187022–143.187102	3

Craftsman Engines Cross Reference Chart (cont.)

Craftsman Engine Models	See Column
143.191012–143.191052	1
143.194012–143.194052	2
143.194062	4
143.194072–143.194092	2
143.194102	4
143.194112–143.194142	2
143.195012	9
143.195022	
143.197012	3
143.197022	5
143.197032	
143.197042–143.197072	3
143.197082	5
143.201032–143.203012	1
143.204022	4
143.204032–143.204052	2
143.204062	4
143.204072–143.204092	2
143.204102	4
143.204132	
143.204142–143.204192	2
143.204202	4
143.205022	9
143.207012–143.207052	3
143.207062	5
143.207072	3
143.207082	5
143.213012–143.213042	1
143.214012–143.214032	2
143.214042–143.214072	4
143.214082–143.214252	2
143.214262–143.214282	4
143.214292	2
143.214302	
143.214312	4
143.214322	
143.214332	2
143.214342	
143.214352	4
143.216042–143.216062	3
143.217012–143.217032	5
143.217042–143.217072	3
143.217092	5
143.217102	3
143.223012–143.223052	1
143.224012	2
143.224022	
143.224032	4
143.224062	2
143.224072	4
143.224092–143.224132	2
143.224142	1
143.224162–143.224222	2
143.224232	4
143.224242	
143.224252–143.224282	2
143.224292	4
143.224302	
143.224312–143.224342	2
143.224352	4
143.224362	
143.224372–143.224422	2
143.224432	4
143.225012	13
143.225022	
143.225032–143.225052	9
143.225062	13
143.225072	
143.225082–143.225102	9
143.227012–143.227072	12
143.233012	1
143.233032	
143.233042	
143.234022–143.234052	2
143.234062–143.234092	4
143.234102–143.234162	2
143.234192	
143.234202	
143.234212–143.234232	4
143.234242–143.234262	2
143.235012	13
143.235022	
143.235032	6
143.235042	13
143.235052	
143.235062	9
143.235072	6
143.237012	12
143.237022	
143.237032	5
143.237042	3
143.244032	2
143.244042	4
143.244052	
143.244062	
143.244072–143.244112	2
143.244122–143.244142	4
143.244202	2
143.244212	4
143.244222	2
143.244232	
143.244242	4
143.244252	4
143.244262–143.244282	2
143.244292–143.244332	4
143.245012	6
143.245042	9
143.245052–143.245072	13
132.245082	
143.245092	6
143.245102–143.245132	13
143.245142	6
143.245152	
143.245162	13
143.245172	6
143.245182	
143.245192	13
143.254012–143.254052	2
143.254062	4
143.254072–143.254122	2
143.254142–143.254192	4
143.254212	2
143.254222	
143.254232–143.254292	4
143.254302	2
143.254312	
143.254322	4
143.254332	2
143.254342	4
143.254352	
143.254362	2
143.254372	4
143.254382	
143.254392	2
143.254402	4
143.254412	
143.254432	2
143.254442	4
143.254452	2
143.254462	4
143.254472	2
143.254482	
143.254492	4
143.254502–143.254532	2
143.255012–143.255112	6
143.257012–143.257072	3
143.264012–143.264042	2
143.264052–143.264082	4
143.264092	2
143.264102	4
143.264232–143.264342	2
143.264352–143.264372	4
143.264382	2
143.264392–143.264412	4
143.264422	2
143.264432–143.264482	4
143.264492	2
143.264502	
143.264512	4
143.264522	2
143.264542	
143.264562–143.264672	4
143.264682	2
143.265012–143.265192	6
143.267012–143.267042	3
143.274022–143.274072	4
143.274092–143.274132	2
143.274142	4
143.274152	
143.274162–143.274182	2
143.274192–143.274242	4
143.274252	2
143.274262	4
143.274272–143.274322	2
143.274402–143.274482	4
143.275012–143.275052	6
143.276022	4
143.277012	3
143.277022	
143.284012	2
143.284022	1
143.284032	2
143.284042	4
143.284052	2
143.284062	
143.284072	4

Craftsman Engines Cross Reference Chart (cont.)

Craftsman Engine Models	See Column
143.284082	2
143.284092	
143.284102	4
143.284112	2
143.284142	
143.284152	
143.284162	
143.284182	
143.284212	4
143.284312	2
143.284322	
143.284332	4
143.284342	
143.284352	
143.284382	4
143.284402	2
143.284412	
143.284432	4
143.284362	
143.284392	2
143.284442	
143.284482	
143.284452	4
143.284472	
143.285012	6
143.285022	
143.285032	
143.521081	9
143.525021	9
143.526011	
143.531052	1
143.531082	
143.531122	
143.531132	
143.531142	2
143.531152	1
143.531172	
143.531182	
143.534012–143.534072	2
143.535012–143.535062	9
143.537012	7
143.541012	1
143.541042–143.541062	1
143.541112–143.541152	1
143.541172–143.541202	1
143.541222	1
143.541282–143.541302	1
143.544012–143.544042	2
143.545012–143.545042	9
143.547012–143.547032	7
143.551012	1
143.551032	
143.551052–143.551192	1
143.554012–143.554082	2
143.555012–143.555052	9
143.557012–143.557082	7
143.565022	9
143.566212	9
143.567012–143.567042	7
143.571002–143.571122	1
143.571152	2
143.571162	1
143.571172	
143.574022–143.574102	2
143.575012–143.575042	9
143.581002–143.581102	1
143.584012–143.584142	2
143.585012–143.585042	9
143.587012–143.587042	3
143.591012–143.591142	1
143.594022–143.594082	2
143.594092	2
143.594102	
143.595012	9
143.595042	
143.597012–143.597032	3
143.601022–143.601062	1
143.604012	2
143.604022	4
143.604032	2
143.604042	
143.604052	4
143.604062	2
143.604072	
143.605012	9
143.605022	
143.605052	
143.607012–143.607032	3
143.607042–143.607062	3
143.611012–143.611112	1
143.614012–143.614032	4
143.614042	2
143.614052	4
143.614062–143.614162	2
143.615012–143.615092	9
143.617012–143.617182	3
143.621012–143.621092	1
143.624012–143.624112	2
143.625012–143.625132	9
143.627012–143.627042	3
143.631012–143.631092	1
143.634012	2
143.634032	
143.635012	9
143.635022	
143.635032	6
143.635052	9
143.637012	3
143.641012–143.641062	1
143.641072	2
143.644012–143.644082	2
143.645012–143.645032	6
143.647012–143.647062	3
143.651012–143.651072	1
143.654022–143.654322	2
143.655012	6
143.655032	
143.657012–143.657052	3
143.661012–143.661062	1
143.664012–143.664332	2
143.665012–143.665082	6
143.667012	3
143.667022	
143.667032	6
143.667042–143.667082	3
143.674012	2
143.675012	6
143.675022	
143.675032	9
143.675042	6
143.677012	3
143.677022	
143.686072	9
143.687012	3
143.694126	4
143.694132	2

Torque Specifications

Model/Part	Inch Pounds	Ft. Pounds
Cylinder Head Bolts	160–200	13–16
Connecting Rod Bolts	65–75	5.5–6
TVS75, 90 & 105, 2.5 thru 4 H.P. (Durlok Rod Bolts)	95–110	7.9–9.1
4–5 H.P. Small Frame	80–95	6.6–7.9
ECH90, ECV100, TNT100	75–80	6.2–6.7
TVS120, 5 H.P. Small Frame (Durlok Rod Bolts)	110–130	9.1–10.8
5–6 H.P. Medium Frame	86–110	7.1–9.1
5–6 H.P. Medium Frame (Durlok Rod Bolts)	130–150	10.8–12.5
ECV105, ECV110, ECV120, TNT120	80–95	6.6–7.9
7, 8 & 10 Medium Frame	106–130	8.8–10.8
7, 8 & 10 Medium Frame (Durlok Rod Bolts)	150–170	12.5–14.1
Cylinder Cover or Flange-to-Cylinder	65–110	5.5–9
Cylinder Cover 5–7 H.P. Medium Frame, H Models	100–140	8.3–11.6
Flywheel Nut	360–396	30–33
Spark Plug	180–360	15–30
Magneto Stator to Cylinder	40–90	3.3–7.5
Starter to Blower Housing or Cylinder	40–60	3.5–5
Housing Baffle to Cylinder	48–72	4–6
Breather Cover (Top Mount ECV)	40–50	3.3–4.1
Breather Cover	20–26	1.7–2.1
Intake Pipe to Cylinder	72–96	6–8
Carburetor to Intake Pipe	48–72	4–6
Air Cleaner to Carburetor (Plastic)	8–12	1
Tank Plate to Bracket (Plastic)	100–144	9–12
Tank to Housing	45–65	3.7–5
Muffler Bolts to Cylinder		
1–5 H.P. Small Frame	30–45	2.5–3.5
4–5 H.P. Medium Frame	90–150	8–12
6:1 Gear Reduction Cover to Housing	100–144	8.5–12
Gear Reduction Cover to Housing	65–110	5–9
Oil Drain Plug		
1/8—27	35–50	1.1–4.1
1/4—18	65–85	4.5–7
3/8—18	80–100	6.6–9
5/8—18	90–150	7.5–12.5
1/2—14	80–100	6.6–9
Ball Bearing Retainer 2.5		
2.5–5 H.P. Small frame	45–60	3.7–5
5–10 H.P. Medium frame	15–22	1.5
Craftsman Exclusive Fuel System to Cylinder	72–96	6–8
Electric Starter-to-Cylinder	50–60	4–5

Engine Specifications

Reference Column	1	2	3	4	5	6	7	8	9	10	11	12
Displacement	7.75	9.06	10.5	10.0	10.5	12.0	11.04	12.17	11.5	12.0	10.0	12.0
Stroke	1 27/32"	1 27/32"	1 15/16"	1 27/32"	1 15/16"	1 15/16"	2 1/4"	2 1/4"	1 15/16"	1 15/16"	1 27/32"	1 15/16"
Bore	2.3125 2.3135	2.5000 2.5010	2.625 2.626	2.625 2.626	2.625 2.626	2.812 2.813	2.5000 2.5010	2.625 2.626	2.750 2.751	2.812 2.813	2.625 2.626	2.812 2.813
Timing Dimension Before Top Dead Center for Vertical Engines	V.060 .070	V.065	V.035	.035	.035	V.040 .060	V.050	H.050	V.035	V.035	V.035	V.035
Timing Dimension Before Top Dead Center for Horizontal Engines	H.060 .070	H.030 .040	H.035			H.055	H.050	H.050				
Point Setting	.020	.020	.020	.020	.020	.020	.020	.020	.020	.020	.020	.020
Spark Plug Gap	.030	.030	.030	.030	.030	.030	.030	.030	.030	.030	.030	.030
Valve Clearance	.010 Both	.010 Both	.010 Both	.010 Both	.010 Both	.010 Both	.010 Both	.010 Both	.010 Both	.010 Both	.010 Both	.010 Both
Valve Seat Angle	46°	46°	46°	46°	46°	46°	46°	46°	46°	46°	46°	46°
Valve Spring Free Length	1.135"	1.135"	1.135"	1.135"	1.135"	1.135"	1.562"	1.462"	1.135"	1.135"	1.135"	1.135"
Valve Guides Over-Size Dimensions	.2805 .2815	.2805 .2815	.2805 .2815	.2805 .2815	.2807 .2817	In. .280 Ex. .278	.3432 .3442	.343 .344	.2805 .2815	.2805 .2815	.2805 .2815	.2805 .2815
Valve Seat Width	.035 .045	.035 .045	.035 .045	.035 .045	.035 .045	.035 .045	.042 .052	.042 .052	.035 .045	.035 .045	.035 .045	.035 .045
Crankshaft End Play	.005 .027	.005 .027	.005 .027	.005 .027	.005 .027	.005 .027	.005 .027	.005 .027	.005 .027	.005 .027	.005 .027	.005 .027
Crankpin Journal Diameter	.8610 .8615	.8610 .8615	.9995 1.0000	.8610 .8615	.9995 1.0000	.9995 1.0000	1.0615 1.0620	1.0615 1.0620	.9995 1.0000	.9995 1.0000	.8610 .8615	.9995 1.0000
Cylinder Main Bearing Dia.	.8755 .8760	.8755 .8760	1.0005 1.0010	.8755 .8760	1.0005 1.0010	1.0005 1.0010	1.0005 1.0010	1.0005 1.0010	1.0005 1.0010	1.0005 1.0010	.8755 .8760	1.0005 1.0010

Cylinder Cover Main Bearing Dia.	.8755 .8760	.8755 .8760	1.0005 1.0010	.8755 .8760	1.2010 1.2020	1.0005 1.0010	1.0005 1.0010	1.0005 1.0010	1.0005 1.0010	1.0005 1.0010	.8755 .8760	1.0005 1.0010
Conn. Rod. Dia. Crank Bearing	.8620 .8625	.8620 .8625	1.0005 1.0010	.8620 .8625	1.0005 1.0010	1.0005 1.0010	1.0630 1.0635	1.0630 1.0635	1.0005 1.0010	1.0005 1.0010	.8620 .8625	1.0005 1.0010
Piston Diameter	2.3090 2.3095	2.4950 2.4955	2.6260 2.6205	2.6200 2.6205	2.604 2.608	2.8070 2.8075	2.492 2.4945	2.6210 2.6215	2.7450 2.7455	2.8070 2.8075	2.6200 2.6205	2.8070 2.8075
Piston Pin Diameter	.5629 .5631	.5629 .5631	.5629 .5631	.5629 .5631	.5631 .5635	.5629 .5631	.6248 .6250	.6248 .6250	.5629 .5631	.5629 .5631	.5629 .5631	.5629 .5631
Width of Comp. Ring Groove	.0955 .0977	.0955 .0975	.0925 .0935	.0955 .0975	.0955 .0975	.0955 .0975	.0955 .0975	.0955 .0975	.0795 .0815	.0955 .0975	.0955 .0975	.0955 .0975
Width of Oil Ring Grooves	.125 .127	.125 .127	.156 .158	.156 .158	.156 .158	.156 .158	.156 .158	.156 .158	.1565 .1585	.1565 .1585	.1565 .1585	.1565 .1585
(Top) Comp. Side Clearance of Ring Groove	.002 .005	.002 .003	.002 .004	.002 .005	.002 .005	.003 .004	.002 .003	.002 .004	.002 .004	.003 .004	.003 .0045	.0028 .0039
(Bot.) Oil			.001 .004	.001 .004	.001 .004	.002 .003		.002 .004	.001 .002	.001 .002	.0010 .0030	.0018 .0038
Ring End Gap	.007 .020	.007 .020	.007 .020	.007 .020	.007 .020	.007 .020	.007 .020	.007 .020	.007 .020	.007 .020	.007 .020	.007 .020
Top Piston Land Clearance	.0015 .0145	.015 .018	.0165 .0215	.017 .022	.017 .022	.017 .022	.015 .018	.017 .020	.024 .027	.018 .021	.017 .022	.017 .022
Piston Skirt Clearance	.0025 .0040	.0045 .0060	.0045 .0060	.0045 .0060	.0050 .0065	.0045 .0060	.0055 .0070	.0035 .0050	.0045 .0060	.0045 .0060	.0045 .0060	.0045 .0060
Camshaft Bearing Dia.	.4975 .4980	.4975 .4980	.4975 .4980	.4975 .4980	.505 .513	.4975 .4980	.6230 .6235	.6230 .6235	.4975 .4980	.4975 .4980	.4975 .4980	.4975 .4980
Dia. of Crankshaft Mag. Main Brg.	.8735 .8740	.8735 .8740	.9985 .9990	.8735 .8740	.9985 .9990	.9985 .9990	.9985 .9990	.9985 .9990	.9990 .9995	.9990 .9995	.8735 .8740	.9985 .9990
Dia. of Crankshaft P.T.O. Main Brg.	.8735 .8740	.8735 .8740	.9985 .9990	.8735 .8740	.9985 .9990	.9985 .9990	.9985 .9990	.9985 .9990	.9985 .9990	.9985 .9990	.8735 .8740	.9985 .9990

A. For VM80 & HM80 engines only - Displacement is 19.41″

B. For VM80 & HM80 engines only - Bore is 3.125″ (3⅛″).
3.126″

Note C. For VM80 & HM80 engines only - Piston Diameter is 3.1205″
3.1195″

Cross Reference for Vertical Crankshaft Engines

Size	Model	Column
2½ HP	LAV25	1
3HP	LAV30	1
	TVS75	1
3½ HP	LV35	2
	LAV35	2
	TVS90	2
4 HP	LAV40	3
	TVS105	3
	V40 thru V40B	7
	VH40	7
10.0 CI	ECV100	4
	TNT100	14
10.5 CI	ECV105	5
11.0 CI	ECV110	12
5 HP	LAV50	6
	TVS120	6
	V50	9
	VH50	9
12.0 CI	ECV120	13
	TNT120	15

Cross Reference Chart for Horizontal Crankshaft Engines

Size	Model	Column
2½ HP	H25	1
3 HP	H30	1
3½ HP	H35	2
9.0 CI	ECH90	2
4 HP	H40	7
	HH40	7
	HS40	3
5 HP	H50	9
	HH50	9
	HS50	6

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Tecumseh-Lauson 2-Stroke Engines

ENGINE IDENTIFICATION

The identification tags may be located at a variety of places on the engine. The type number is the most important number since it must be included with any correspondence about a particular engine.

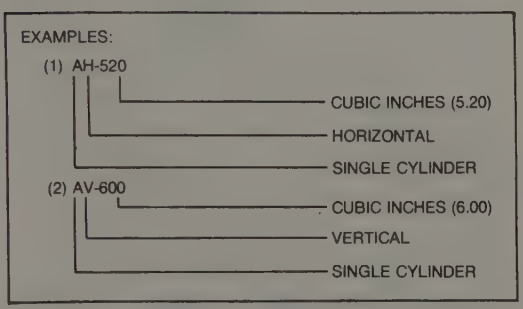
Early engines listed the type number as a suffix of the serial number. For example on number 123456789 P 234, 234 is the type number. In the number 123456789 H 104-02B; 104-02B is the type number. In either case the type number is important.

If you use short block to repair the engine, be sure that you transfer the serial number and type number tag to the new short block.

On the newer engines, reference is sometimes made to the model number. The model number tells the number of cylinders, the design (vertical or horizontal) and the cubic inch displacement.

GENERAL ENGINE SPECIFICATIONS

A detailed listing of the great number of Power Products two-stroke engine models is provided in the Type No./Column No. cross reference chart at the back of this section.

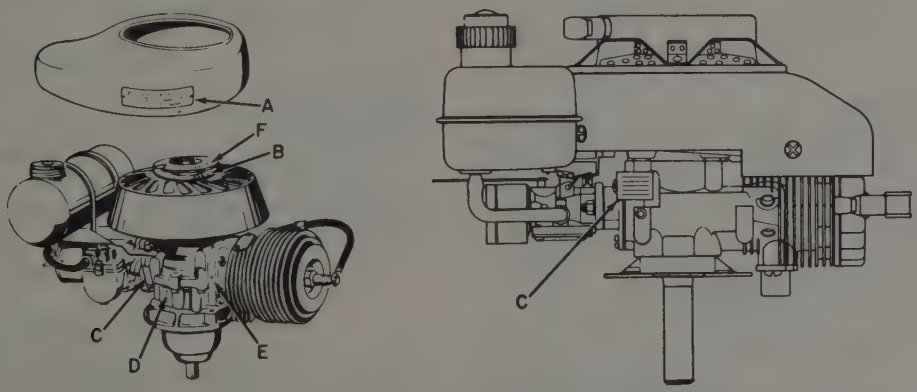


Model number interpretation

MAINTENANCE

Air Cleaners

The instructions below detail the procedures involved in cleaning the various types of elements. See the illustrations for exploded views to aid disassembly and assembly.

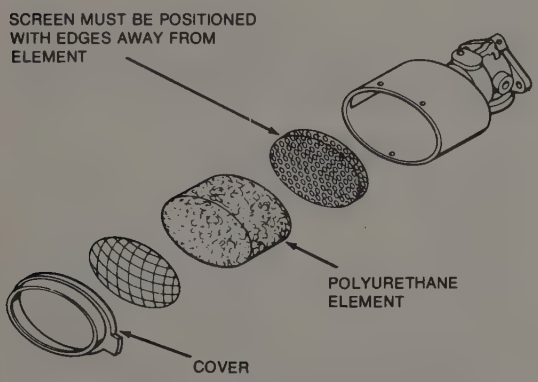


A. NAMEPLATE ON AIR SHROUD
B. MODEL & TYPE NUMBER PLATE
C. METAL TAG ON CRANKCASE
D. STAMPED ON CRANKCASE
E. STAMPED ON CYLINDER FLANGE
F. STAMPED ON STARTER PULLEY

Location of identification numbers on 2 cycle engines

POLYURETHANE AIR CLEANER

1. Wash the element in a solvent or detergent and water solution by squeezing similar to a sponge.
2. Clean the air cleaner housing and cover with the same solution. Dry thoroughly.
3. Dry the element by squeezing or with compressed air if available.
4. Apply a generous quantity of oil to the element sides and open ends. Squeeze vigorously to distribute oil and to remove excess oil.

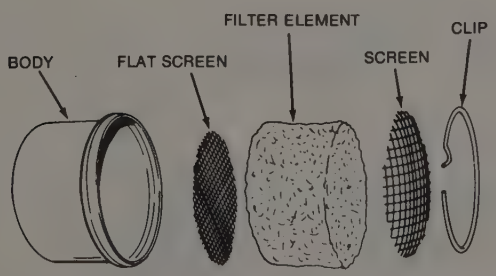


Exploded view of polyurethane air cleaner

ALUMINUM FOIL AIR CLEANER

1. Dip the aluminum foil filter in solvent. Flush out all dirt particles.
2. Shake out the filter thoroughly to remove all solvent, then dip the filter element in oil. Allow the oil to drain from the filter. Clean the screens and filter body.

NOTE: *The concave screen and retainer cover or ring are not used on later models. They are replaced with a clip which rolls into the groove in the lip of the body.*

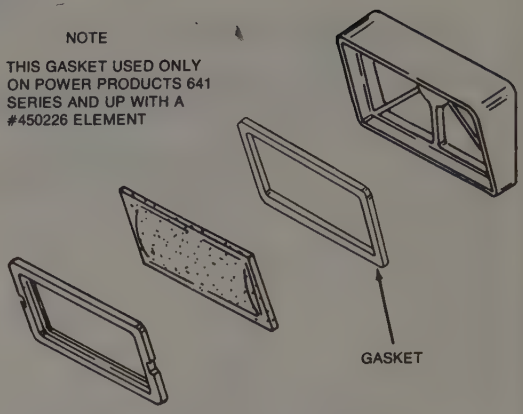


Exploded view of aluminum foil type air cleaner

FELT TYPE AIR CLEANERS

1. To clean felt air cleaners, merely blow compressed air through the element in the reverse direction to normal air flow. Felt elements may also be washed in nonflammable solvents or soapy water. Blow dry with compressed air.

NOTE: *Power Products type numbers 641 and up, use a gasket between the element and the base. The gasket is used only with this element; earlier versions did not have a gasket.*



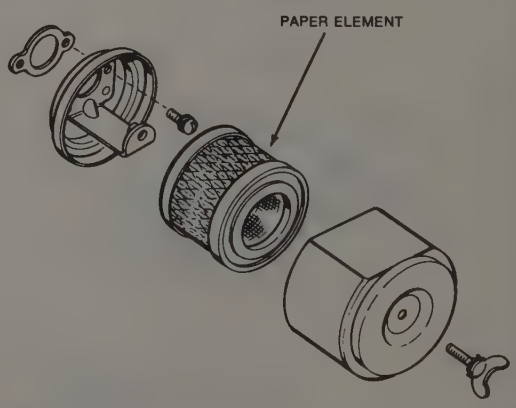
Exploded view of felt type air cleaner

FIBER ELEMENT AIR CLEANER

1. Remove the filter and place the cover in a normal position on the filter. With the filter element down to semi-seal it, blow compressed air through the cover hole to reverse air flow, forcing dirt particles out.
2. Clean the cover mounting bracket with a damp cloth.

DRY PAPER AIR CLEANER

1. Tap the element on a workbench or any solid object to dislodge larger particles of dirt.
2. Wash the element in soap and water. Rinse from the inside until it is thoroughly flushed and the water coming through is free of soap.
3. Allow the element to dry completely or use low pressure compressed air blown from the inside to speed the process.



Exploded view of paper element type air cleaner

4. Inspect the element for cracks or holes, and replace if necessary.

Lubrication

OIL AND FUEL RECOMMENDATIONS

Power Products 2 cycle engines are mist-lubricated by oil mixed with the gasoline. For the best performance, use regular grade, leaded fuel, with 2 cycle or outboard oil rated SAE 30 or SAE 40. Regular grade unleaded fuel is an acceptable substitute. The terms 2 cycle or outboard are used by various manufacturers to designate oil they have designed for use in 2 cycle engines. Multiple weight oil such as all season 10W-30, are not recommended.

If you have to mix the gas and oil when the temperature is below 35°F, heat up the oil first, then mix it with the gas. Oil will not mix with gas when the temperature is approaching freezing. However, if you use oil that has been warmed first it will not be affected by low temperatures.

The proportion of oil to fuel is absolutely critical to two-stroke operation. If too little oil is used, overheating and damage to engine parts will occur (this can even result from running the engine too lean). If excessive oil is used, spark plug fouling, smoke in the exhaust, and even misfire can occur. Mix carefully and precisely. Follow Power Products recommendations for *your particular engine*, and *disregard* fuel container labels.

Fuel/oil mix must be clean and fresh. Fuel deteriorates enough to form troublesome gum and varnish after more than a month. Dirt in the fuel can cause clogging of carburetor passages and even engine wear.

TUNE-UP

Specifications

All spark plugs are gapped at .035 in. Because of the great number of individual models of Power Products engines that exist, an individual chart of Tune-Up specifications is impractical. Refer to the charts at the end of this section for breaker point gap and timing dimension specifications.

Spark Plugs

Spark plugs should be removed and cleaned of deposits frequently, especially in two-stroke engines because they burn the lubricating oil right with the fuel. Carefully inspect the plug for severely eroded electrodes or a cracked insulator, and replace the plug if either condition exists or if deposits cannot be adequately removed. Set the gap to .035 in. with a *wire* type feeler gauge, and install the plug, torquing it to 18–22 ft. lb.

Make sure to replace the plug with one of the same type and heat range. If the plug is fouled, poor quality or old fuel, a rich mixture, or the wrong fuel/oil mix may be at fault. Also, make sure the engine's exhaust ports are not clogged.

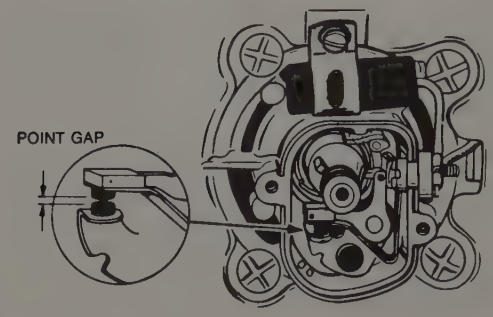
Breaker Points

REMOVAL AND INSTALLATION

1. First remove the flywheel as described below:
   a. Remove the screws, engine shroud, and starter. Determine the direction of rotation of the flywheel nut by looking at the threads. Then, place a box wrench on the nut and tap with a soft hammer in the proper direction.
   b. The flywheel is removed with a special puller or a special knock off tool. The knock off tool must not be used on 660, 670, or 1500 ball bearing models. To use the knock off tool, screw it onto the crankshaft until it is within 1/16 in. of the flywheel. Hold the flywheel firmly and rap the top of the puller sharply with a hammer to jar it loose. Pull the flywheel off.
   c. If a puller is being used, the flywheel will have three cored holes into which a set of self-tapping screws are turned. The handle which operates the bolt at the center of the puller's collar is then turned to pull the flywheel off the crankshaft. If this is not adequate to do the job, heat the center of the alloy flywheel with a butane torch to expand it before turning the puller handle.
2. Remove the nuts that hold the electrical leads to the screw on the movable breaker point spring. Remove the movable breaker point from the stud.
3. Remove the screw and stationary breaker point. Put a new stationary breaker point on breaker plate; install the screw, but do not tighten it fully.
4. Position a new movable breaker point on the post.
5. Check that the new points contact each other properly and remove all grease, fingerprints, and dirt from the points.

ADJUSTMENT

1. If necessary (as when checking the gap of old points), loosen the screw which mounts the stationary breaker contact. Rotate the



Adjusting point gap

crankshaft until the contact cam follower rests right on the highest point of the cam.

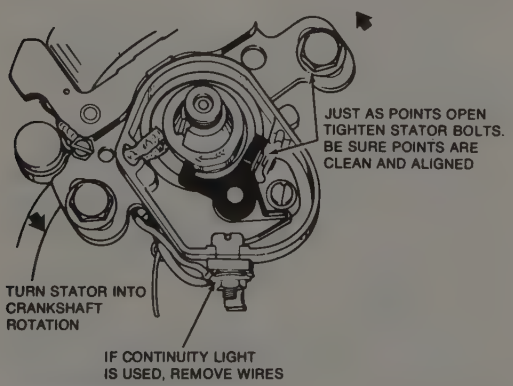
2. Using a flat feeler gauge of the dimension shown under "point gap" in the charts at the rear of this section, check the dimension of the gap and, if incorrect, move the breaker base in the appropriate direction by wedging a screwdriver between the dimples on the base plate and the notch in the breaker plate. When gap is correct, tighten the screw. Recheck the gap and, if necessary, reset it.

Adjusting Ignition Timing

1. Remove the spark plug and install a special timing tool or thin ruler. With the tool lockscrew loose or the ruler riding on the piston, rotate the crankshaft back and forth to find Top Dead Center. Tighten the tool lockscrew or use a straightedge across the cylinder head, if you're using a ruler, to measure Top Center. Look up the timing dimension in the specifications at the back of this section.

2. Turn the crankshaft backwards so the piston descends. Then, reset the position of the special tool downward the amount of the dimension and tighten the lockscrew, or move the ruler down that amount.

3. Very carefully bring the piston upward by turning the crankshaft until the top of the piston just touches the tool or ruler.


JUST AS POINTS OPEN TIGHTEN STATOR BOLTS. BE SURE POINTS ARE CLEAN AND ALIGNED
TURN STATOR INTO CRANKSHAFT ROTATION
IF CONTINUITY LIGHT IS USED, REMOVE WIRES

Adjusting ignition timing

4. Install a piece of cellophane between the contact surfaces. Loosen the ignition stator lockscrews and turn the stator until the cellophane is clamped tightly between the contact surfaces. Turn the stator until the cellophane can just be pulled out (as contacts start to open), and then tighten the stator lockscrews.

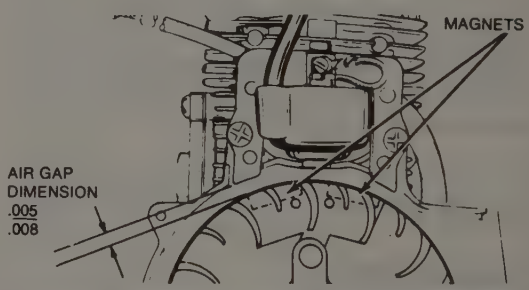
Magneto Armature Air Gap

There are two types of magnetos. Compare appearance of your engine with each illustration to determine whether it looks like the type which employs a gap of .005–.008 in. or the type with a gap of .015 in.

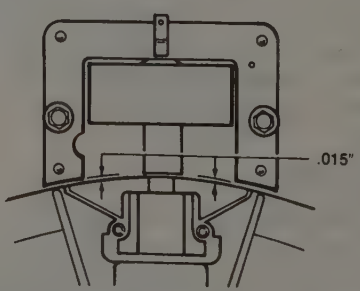
1. Loosen the two screws which hold the laminations and coil to the block. Turn the flywheel around so the magnets line up directly with the ends of the laminations. Pull the laminations/coil assembly upward.

2. Insert an air gap gauge (Power Products Part #670216) or an equivalent (.005–.008 in.) gauge between the flywheel and laminations on either side. On units with a gap of .015 in., use two of the above numbered parts or a .015 in. gauge. Allow the attraction of the magnets to pull the coil/laminations assembly toward the flywheel.

3. On the magneto type with a .005–.008 in. dimension, use Loctite Grade A on the screws and torque to 35–45 in. lbs. On the other type magneto, torque the screws to 20–



Adjusting magneto armature air gap. Note magnets on flywheel



Adjusting magneto armature air gap. Note wider gap

30 in. lbs. Recheck the gap and readjust, if necessary.

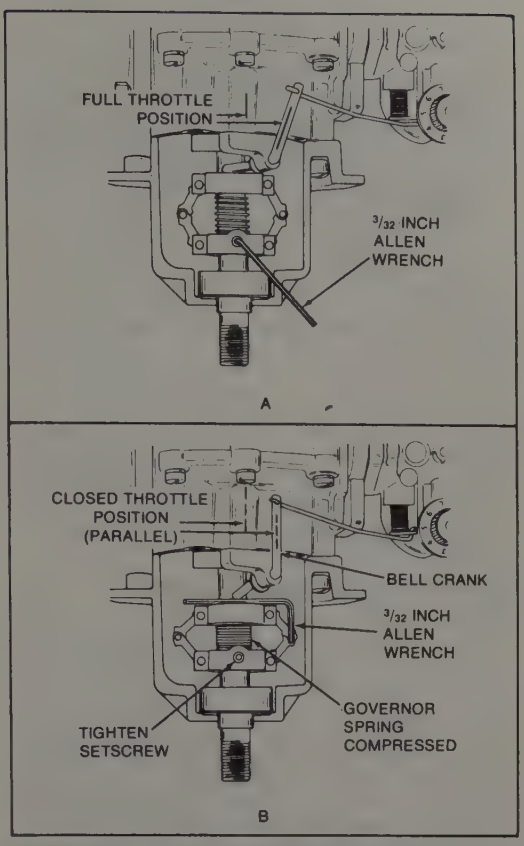
Mixture Adjustment

1. If the engine will not start or the carburetor has recently been disassembled, both idle and main mixture screws may be turned in *very gently* until they *just* bottom, and then turned out exactly one turn. In this case, back out the idle speed screw until throttle is free, then turn screw in until it just contacts the throttle. Turn it one turn more exactly.

2. Allow the engine to warm up to normal running temperature. With the engine running at maximum recommended rpm, loosen the main metering screw until the engine rolls, then tighten the screw until the engine starts to cut out. Note the number of turns from one extreme to the other. Loosen the screw to a point midway between the extremes.

3. Set the throttle to idle speed and repeat Step 2 for that adjusting screw.

NOTE: *Some carburetors do not have a main mixture adjustment. Others employ a drilled mixture screw which provides about the right mixture when fully screwed in. In some weather conditions, operation may be improved by setting this screw just slightly off the seat for smoother running.*



Adjusting the PTO end mounted governor

Governor Adjustments

POWER TAKEOFF END MECHANICAL GOVERNOR

1. To adjust the governor, remove the outboard bearing housing. Use a 3/32 in. allen wrench to loosen the set screw.

2. Squeeze the top and bottom governor rings, fully compressing the governor spring.

3. Hold the upper arm of the bell crank parallel to the crankshaft and insert a 3/32 in. allen wrench between the upper ring and the bell crank.

4. Slide the governor assembly onto the crankshaft so that the allen wrench just touches the bell crank.

5. Tighten the set screw to secure the governor to the crankshaft.

6. Install the bearing adapter, mount the engine, and check the engine speed with a tachometer. It should be about 3200 to 3400 rpm.

NOTE: *Never attempt to adjust the governor by bending the bellcrank or the link.*

7. If the speed is not correct, readjust the governor by moving the assembly toward the crankcase to increase speed, and away from the crankcase to decreased speed.

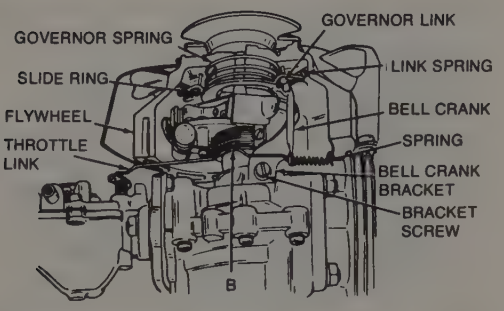
MECHANICAL FLYWHEEL TYPE GOVERNOR ADJUSTMENT

As engine speed increases, the links are thrown outward, compressing the link springs. The links apply a thrust against the slide ring, moving it upward and compressing the governor spring. As the slide ring moves away from the thrust block of the bellcrank assembly, the throttle spring causes the thrust block to maintain engagement and close the throttle slightly.

As the throttle closes and engine speed decreases, force on the slide ring decreases so that it moves downward, pivots the bellcrank outward to overcome the force of the throttle spring, and opens the throttle to speed up the engine. In this manner, the operating speed of the engine is stabilized to the adjusted governor setting.

1. To adjust the governor, loosten the bracket screw and slide the governor bellcrank assembly toward or away from the flywheel. Move the bellcrank toward the flywheel to increase speed and away from the flywheel to decrease speed.

2. Tighten the screw to secure the bracket.



Flywheel mounted governor assembly (cutaway view)

3. Make minor speed adjustments by bending the throttle link at the bend in the center of the link.

NOTE: *Do not lubricate the governor assembly or the governor bellcrank assembly of flywheel mounted governors.*

ADJUSTING 2 CYCLE AIR VANE GOVERNORS

1. Loosen the self-locking nut that holds the governor spring bracket to the engine crankcase.
2. Adjust the spring bracket to increase or decrease the governor spring tension. Increasing spring tension increases speed and decreasing spring tension decreases speed.
3. After adjusting, the spring bracket should not be closer than $^1/_{16}$ in. to the crankcase.
4. Tighten the self-locking nut.

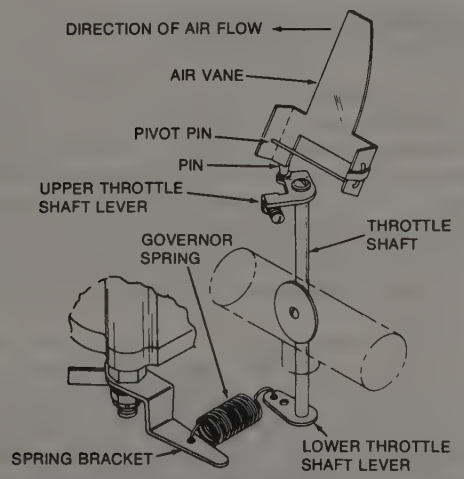


Diagram of an air vane governor

FUEL SYSTEM

Carburetor

REMOVAL AND INSTALLATION

1. Remove the air cleaner. Drain the fuel tank. Disconnect the carburetor fuel lines.
2. If necessary, remove any shrouding or control panels to gain access to the carburetor.
3. Disconnect the choke or throttle control wires at the carburetor.
4. Remove the cap screws, or nuts and lockwashers and remove the carburetor from the engine.
5. To install, reverse the removal procedure, using new gaskets.

OVERHAUL

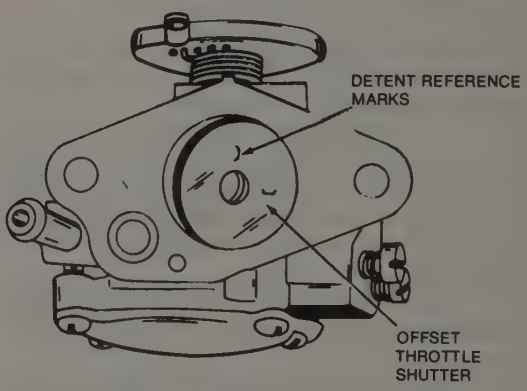
Tecumseh two—and four—stroke engines employ a common series of carburetors. Refer to the Four—Stroke Tecumseh Engine section for specific carburetor overhaul procedures.

Idle Governor

SERVICE

1. Remove the shutter fastener and allow the shutter to drop out of the air horn.
2. Note location of the spring end in the disc-shaped throttle lever. The spring should be placed into the same hole during reassembly.
3. Remove the retainer clip and lift out the throttle shaft.
4. Replace all worn parts and reassemble in reverse order.

NOTE: *Note the position of the throttle shutter, as shown. The reference marks must be positioned as shown when shutter is installed.*



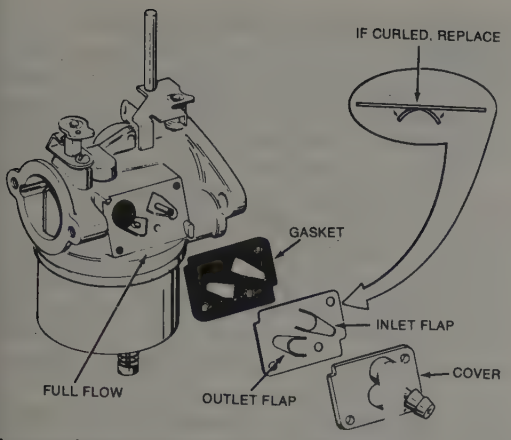
Position detent reference marks of throttle shutter as shown

Fuel Pump

SERVICE

Float Type Carburetor with Integral Pump

1. If the engine runs, but roughly, make both carburetor mixture adjustments.



Integral type fuel pump

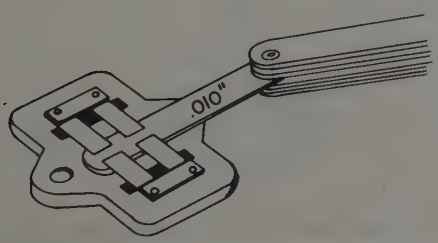
2. Make sure the fuel supply is adequate and the tank is in the proper position.
3. Make sure the fuel tank valve is open.
4. Make sure the pick-up tube is not cracked.
5. Remove the carburetor and make sure the pulsation passage is properly aligned.
6. Check for air leaks at the gasket surface.
7. Remove the cover and check the condition of the inlet and outlet flaps—if curled, replace the flap leaf.

ENGINE OVERHAUL

Disassembly

SPLIT CRANKCASE ENGINES

1. Remove the shroud and fuel tank if so equipped.
2. Remove the flywheel and the ignition stator.
3. Remove the carburetor and governor linkage. Carefully note the position of the carburetor wire links and springs for reinstallation.
4. Lift off the reed plate and gasket if present and inspect them. They should not bend away from the sealing surface plate more than 0.010 in.



Checking the reed valve clearance

5. Remove the spark plug and inspect it.
6. Remove the muffler. Be sure that the muffler and the exhaust ports are not clogged with carbon. Clean them if necessary.
7. Remove the transfer port cover and check for a good seal.
8. Remove the cylinder head, if so equipped.

NOTE: *Some models utilize a locking compound on the cylinder head screws. Removing the screws on such engines can be difficult. This is especially true with screws having slotted head for a straight screwdriver blade. The screws can be removed if heat is applied to the head of the screw with an electric soldering iron.*

9. On engines having a governor mounted on the power take-off end of the crankshaft, remove the screws that hold the outboard bearing housing to the crankcase. Clean the PTO end of the crankshaft and remove the outboard bearing housing and bearing. Loosen the set screw that holds the governor assembly to the crankshaft, slide the entire governor assembly from the crankshaft. Remove the screw that holds the governor bellcrank bracket to the crankcase. Remove the governor bellcrank and bracket.
10. Make match marks on the cylinder and crankcase. Remove the four nuts and lockwashers that hold the cylinder to the crankcase.
11. Remove the cylinder by pulling it straight out from the crankcase.
12. To separate the two crankcase halves, remove all of the screws that hold the crankcase halves together.
13. With the crankcase in a vertical position, grasp the top half of the crankcase and hold it firmly. Strike the top end of the crankcase with a rawhide mallet, while holding the assembly over a bench to prevent damage to parts when they fall. The top half of the crankcase should separate from the remaining assembly.
14. Invert the assembly and repeat the procedure to remove the other casting half from the crankcase on ball bearing units.
15. Each time the crankshaft is removed from the crankcase, seals at the end of the crankcase should be replaced. To replace the seals, use a screwdriver or an ice pick to remove the seal retainers and remove and discard the old seals. Install the seals in the bores of the crankcase halves. The seals must be inserted into the bearing well with the channel groove toward the internal side of the crankcase. Retain the seal with the retainer. Seat the retainer spring into the spring groove.

UNIBLOCK ENGINES

1. Remove the shroud and fuel tank. Note the condition of the air vane governor, if so equipped.

2. Remove the starter cap and flywheel nut, noting the position of the belleville washer.

3. Remove the flywheel—see "Breaker Points Removal and Installation," above.

4. Remove the head. Save the old head gasket for use when replacing the piston, but procure a new gasket for use in final assembly.

5. Remove the cylinder block cover plate to gain access to the connecting rod bolts.

6. Note the location of the connecting rod match marks for reassembly.

7. Remove the piston. Remove the ridge first, if necessary, with a ridge reamer. Push the piston and connecting rod through the top of cylinder.

8. Remove the crankshaft from the cylinder block assembly. On engines with crankshaft ball bearings:

a. Remove the four shroud base screws and tap the shroud base so the base and crankshaft can be removed together.

b. To remove bearing with crankshaft from base: USE SAFETY GLASSES AND HEAT RESISTANT GLOVES. Using a propane torch, heat the area on the base around the outside of the bearing until there is enough expansion to remove the base from the bearing on the crankshaft. Now remove and discard the seal retainer ring, seal retainer and seal.

c. To remove the bearing race, remove the retainer ring on the crankshaft with snap ring pliers, and with the use of a bearing splitter or arbor press, remove the ball bearing.

CAUTION: *Support the crankshaft's top counterweight to prevent bending. also, bearing is to be pressed on via the inner race* only.

On other engines:

When equipped with a sleeve or needle bearing, use a seal protector and lift the crankshaft out of the cylinder. Be careful not to lose the bearing needles.

When equipped with a ball bearing, use a mallet to strike the crankshaft on the P.T.O. end while holding the block in your hand.

9. In assembly, bear the following points in mind:

a. Use a ring compressor to install piston. Be careful not to allow the rings to catch on the recess for the head gasket. Use the old head gasket to take up the space in the recess. *Do not* force the piston into the cylinder, or damage to rings or piston could occur.

b. To install the ball bearing on the crankshaft, slide the bearing on the crankshaft and fit it on the shaft by tapping using a mallet and tool, part number 670258 or press the ball bearing on the crankshaft with an arbor press. Install the retainer ring.

c. To install the crankshaft with a ball bearing, heat the shroud base to expand the bearing seat and drop the ball bearing into the seat of the base shroud. Allow it to cool. Install a new seal retainer ring, seal retainer, and seal.

10. After the shroud base and flywheel are back in place, adjust the air gap between the coil core and flywheel as described above under "Magnet Air Gap Adjustment."

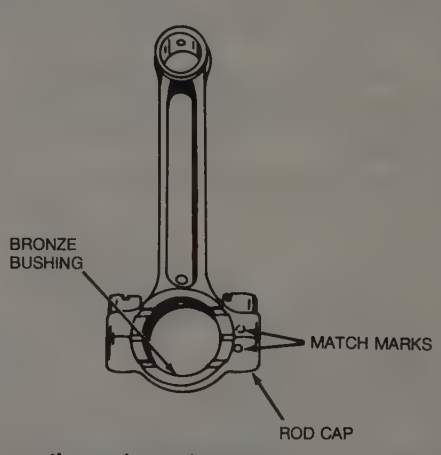
Connecting Rod Service

1. For engines using solid bronze or aluminum connecting rods, remove the two self-locking cap screws which hold the connecting rod to the crankshaft and remove the rod cap. Note the match marks on the connecting rod and cap. These marks must be reinstalled in the same position to the crankshaft.

2. Engines using steel connecting rods are equipped with needle bearings at both crankshaft and piston pin end. Remove the two set screws that hold the connecting rod and cap to the crankshaft, taking care not to lose the needle bearings during removal.

3. Needle bearings at the piston pin end of steel rods are caged and can be pressed out as an assembly if damaged.

4. Check the connecting rod for cracks or distortion. Check the bearing surfaces for scoring or wear. Bearing diameters should be within the limits indicated in the table of specifications located at the end of this section.



Connecting rod match marks

5. There are two basic arrangements of needles supplied with the connecting rod crankshaft bearing: split rows of needles and a single row of needles. Service needles are supplied with a beeswax coating. The beeswax holds the needles in position.

6. To install the needle bearings, first make sure that the crankshaft bearing journal and the connecting rod are free from oil and dirt.

7. Place the needle bearings with the beeswax onto a cool metallic surface to stiffen the beeswax. Body temperature will melt the wax, so avoid handling.

8. Remove the paper backing on the bearings and wrap the needles around the crankshaft journal. The beeswax will hold the needles onto the journal. Position the needles uniformly onto the crankpin.

NOTE: *When installing the split row of needles, wrap each row of needles around the journal and try to seal them together with gentle but firm pressure to keep the bearings from unwinding.*

9. Place the connecting rod onto the journal, position the rod cap, and secure it with the capscrews. Tighten the screw to the proper specifications.

10. Force solvent (lacquer thinner) into the needles just installed to remove the beeswax, then force 30W oil into the needles for proper lubrication.

Piston and Rings Service

1. Clean all carbon from the piston and ring grooves.

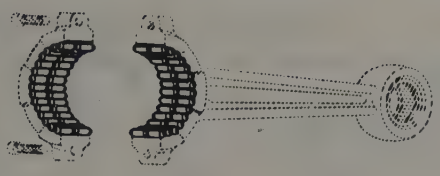
2. Check the piston for scoring or other damage.

3. Check the fit of the piston in the cylinder bore. Move the piston from side-to-side to check clearance. If the clearance is not greater than 0.0003 in. and the cylinder is not scored or damaged, then the piston need not be replaced.

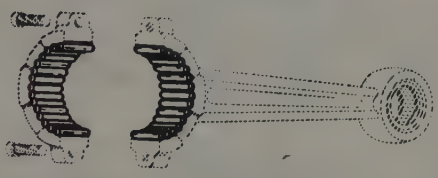
4. Check the piston ring side clearance to make sure it is within the limits recommended.

5. Check the piston rings for wear by inserting them into the cylinder about ½ in. from the top of the cylinder. Check at various places to make sure that the gap between the ends of the ring does not exceed the dimensions recommended in the specifications table at the end of this section. Bore wear can be checked in the same way, except that a new ring is used to measure the end gap.

6. If replacement rings have a bevelled or chamfered edge, install them with the bevel up toward the top of the piston. Not all engines use bevelled rings. The two rings installed on the piston are identical.



A. SPLIT ROWS OF NEEDLE BEARINGS



B. SINGLE ROW OF NEEDLE BEARINGS

Needle bearing arrangement. Double rows of bearings are placed with the tapered edges facing out

7. When installed, the offset piston used on the AV600 and the AV520 engines must have the "V" stamped in the piston head (some have hash marks) facing toward the right as the engine is viewed from the top or piston side of the engine.

NOTE: *Some AV520 and AV600 engines do not have offset pistons. Only offset pistons will have the "V" or the hash marks on the piston head. Domed pistons must be installed so that the slope of the piston is toward the exhaust port.*

Crankshaft Service

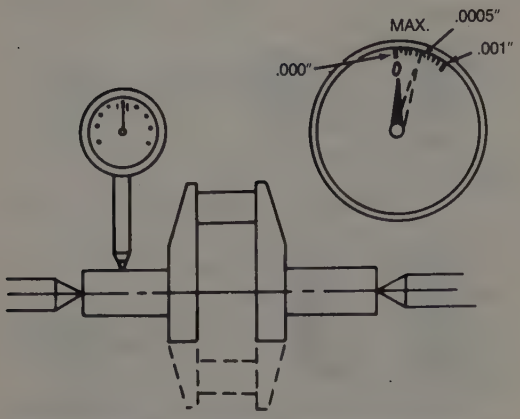
1. Use a micrometer to check the bearing journals for out-of-roundness. The main bearing journals should not be more than 0.0005 in. out-of-round. Connecting rod journals should not be more that 0.001 in. out-of-round. Replace a crankshaft that is not within these limits.

NOTE: *Do not attempt to regrind the crankshaft since undersize parts are not available.*

2. Check the tapered portion of the crankshaft (magneto end), keyways, and threads. Damaged threads may be restored with a thread die. If the taper of the shaft is rusty, it indicates that the engine has been operating with a loose flywheel. Clean the rust off the taper and check for wear. If the taper or keyway is worn, replace the crankshaft.

3. Check all of the bearing journal diameters. They should be within the limits indicated in the specifications table at the end of this section.

4. Check the crankshaft for bends by plac-



Checking the crankshaft for out-of-roundness

ing it between two pivot points. Position the dial indicator feeler on the crankshaft bearing surface and rotate the shaft. The crankshaft should not be more than 0.002 to 0.004 in. out-of-round.

Bearing Service

1. Do not remove the bearings unless they are worn or noisy. Check the operation of the bearings by rotating the bearing cones with your fingers to check for roughness, binding, or any other signs of unsatisfactory operation. If the bearings do not operate smoothly, remove them.

2. To remove the bearings from the crankcase, the crankcase must be heated. Use a hot plate to heat the crankcase to no more than 400°F. Place a ⅛ in. steel plate over the hot plate to prevent overheating. At this temperature, the bearings should drop out with a little tapping of the crankcase.

3. The replacement bearing is left at room temperature and dropped into the heated crankcase. Make sure that the new bearing is seated to the maximum depth of the cavity.

NOTE: *Do not use an open flame to heat the crankcase halves and do not heat the crankcase halves to more than 400°F. Uneven heating with an open flame or excessive temperature will distort the case.*

4. The needle bearings will fall out of the bearing cage with very little urging. Needles can be reinstalled easily by using a small amount of all-purpose grease to hold the bearings in place.

5. Cage bearings are removed and replaced in the same manner as ball bearings.

6. Sleeve bearings cannot be replaced. Both crankcase halves must be discarded if a bearing is worn excessively.

Assembly

1. The gasket surface where the crankcase halves join must be thoroughly clean before reassembly. Do not buff or use a file or any other abrasive that might damage the mating surfaces.

NOTE: *Crankcase halves are matched. If one needs to be replaced, then both must be replaced.*

2. Place the PTO half of the crankcase onto the PTO end of the crankshaft. Use seal protectors where necessary.

3. Apply a thin coating of sealing compound to the contact surface of one of the crankcase halves.

4. Position one crankcase half on the other. The fit should be such that some pressure is required to bring the two halves together. If this is not the case, either the crankcase halves and/or the crankshaft must be replaced.

5. Secure the halves with the screws provided, tightening the screws alternately and evenly. Before tightening the screws, check the union of the crankcase halves on the cylinder mounting side. The halves should be flat and smooth at the union to provide a good mounting face for the cylinder. If necessary, realign the halves before tightening the screws.

6. The sleeve tool should be placed into the crankcase bore from the direction opposite the crankshaft. Insert the tapered end of the crankshaft through the half of the crankcase to which the magneto stator is mounted. Remove the seal tools after installing the crankcase halves.

7. Stagger the ring ends on the piston and check for the correct positioning on domed piston models.

8. Place the cylinder gasket on the crankcase end.

9. Place the piston into the cylinder using the chamfer provided on the bottom edge of the cylinder to compress the rings.

10. Secure the cylinder to the crankcase assembly.

Type Number-to-Letter Cross Reference Chart

Type No.	Column Letter
1 thru 44	A
46 thru 68	B
69 thru 77	D
78 thru 80	C
81 thru 83	D
84 thru 85	C
86 thru 87	B
89	C
91	D
93	D
94 thru 98	H
99	C
201 thru 208	A
209 thru 244	B
245	D
246 thru 248	B
249 thru 251	D
252	B
253 thru 255	D
256 thru 261	B
262 thru 265A	D
266 thru 267	B
268 thru 272	D
273 thru 275	B
276	D
277 thru 279	B
280 thru 281	D
282	B
283 thru 284	D
285 thru 286	B
287	D
288 thru 291B	B
292 thru 294	D
295 thru 296	B
297	F
298 thru 299	B
301 thru 375 These are twin cylinder units– out of production	
401 thru 402	L
403	M
404 thru 406B	L
407 thru 407C	M
408 thru 410B	L
411 thru 411B	M
412 thru 423	L
424 thru 427	M
501 thru 509A	E
601 thru 601–01	F
602 thru 602–02B	F
603A thru 603–23	E
604 thru 604–25	E
605 thru 605–18	E
606 thru 606–05B	E
606–06 thru 606–07	F
606–08 thru 606–13	E
608 thru 608–C	E
610–A thru 610–14	E
610–15 thru 610–16	F
610–19 thru 610–20	E
611	F
614–01 thru 614–04	E
614–05 thru 614–06A	F
615–01 thru 615–01A	E
615–04	F
615–05 thru 615–10A	E
615–11 thru 615–18	F
615–19 thru 615–27A	E
615–28	F
615–29 thru 615–39	E
616–01 thru 616–11	E
616–12 and 616–14	F
616–16 thru 616–40	E
617A thru 617–01	E
617–02 thru 617–03A	F
617–04 thru 617–04A	E
617–05 thru 617–05A	F
617–06	E
618 thru 618–16	E
618–17	F
618–18	E
619 thru 619–03	E
621 thru 621–11	E
621 thru 621–12A	F
621–13 thru 621–15	E
622 thru 622–07	E
623 and 623A	E
623–01	F
623–02 thru 623–33E	E
623–34	F
623–35 and 623–36	E
624 thru 630–09	J
632–02A	K
632–04 and 632–05A	K
633 thru 634–09	J
635A and B	K
635–03B	K
635–04B	K
635–06A thru 635–10	K
636 thru 636–11	J
637 thru 637–16	J
638 thru 638–100	F
639	M
640	O
641	K
642	I
643	J
650	N
670	H
701 thru 701–1C	G
701–2 thru 701–2D	H
701–3 thru 701–3C	G
701–4 thru 701–4C	H
701–5 thru 701–5C	G
701–6 thru 701–6C	H
701–7 thru 701–7C	G
701–8 thru 701–11	H
701–12 thru 701–13A	G
701–14 thru 701–17	H
701–18 thru 701–19	G
701–19A	H
701–20 thru 701–22A	G
701–24	H
1001	D
1002 thru 1002D	G
1003	C
1004 thru 1004A	H
1005 thru 1005A	C
1006	H
1007 thru 1008B	C
1009 thru 1010B	G
1011 thru 1019E	H
1020	G
1021	C
1022 thru 1022C	D
1023 thru 1026A	H
1027 thru 1027B	C
1028 thru 1030C	H
1031B thru 1031C	G
1032	C
1033 thru 1033F	G
1034 thru 1034G	H
1035 thru 1036	C
1037 thru 1039C	D
1040 thru 1041A	D
1042 thru 1042C	G
1042D thru 1042E	H
1042F	G
1042G and 1042H	H
1042I thru 1043B	G
1043C thru 1043F	H
1043G thru 1044E	G
1045 thru 1045F	B
1046 thru 1051B	H
1052	G
1053 thru 1054C	H
1055 thru 1056B	G
1057	H
1058 thru 1058A	G
1059	D
1060 thru 1060C	H
1061 and 1062	C
1063A thru 1063C	H
1064	G
1065 thru 1067C	D
1068 and 1068A	G
1069	H
1070 thru 1070B	C
1071 thru 1075D	H
1076 thru 1084	H
1085 and 1085A	G
1086 thru 1140A	H
1141 thru 1142	G
1143 thru 1145	H
1146 thru 1149A	I
1149A thru 1153B	H
1158 thru 1159	G
1160 thru 1161A	I
1162 and 1162A	G
1163 thru 1163A	H
1165 thru 1168A	G
1169 thru 1174	H
1175 and 1175A	I
1176 thru 1177A	H
1179 thru 1179A	I
1180 thru 1181	G
1182 and 1182A	I

Type Number-to-Letter Cross Reference Chart (cont.)

Type No.	Column Letter	Type No.	Column Letter	Type No.	Column Letter
1183 thru 1185	G	1345	J	1441	P
1186A thru 1186C	J	1348 and 1348A	G	1442 thru 1442B	G
1187 thru 1192	G	1350 thru 1350C	I	1443	I
1192A thru 1196B	J			1444 and 1444A	G
1197 thru 1197A	G	1550A	P	1445	I
1198 and 1198A	H			1446 and 1446A	A
1199 and 1199A	J	1351 thru 1351B	K	1447	G
		1352 thru 1352B	I	1448 thru 1450	F
1206 thru 1208B	J	1353	K	1450A thru 1450B	F
1210 thru 1215C	K	1354 thru 1355A	I	1450C thru 1450E	F
1216 thru 1216A	H	1356 and 1356B	K	1453	K
1217 thru 1220A	J	1357 thru 1358	I	1454 and 1454A	A
1221	H	1359 thru 1362B	K	1455 thru 1456	K
1222 thru 1223	J	1363 thru 1369A	G	1459	G
1224 thru 1225A	H	1372 thru 1375A	G	1460 thru 1460F	A
1226 thru 1227B	K	1376 and 1376A	J	1461	K
1228 thru 1229A	J	1377 thru 1378	K	1462	A
1230 thru 1231	H	1379 thru 1379A	H	1463	K
1232	G	1380 thru 1380B	K	1464 thru 1464B	L
1233 thru 1237B	K	1381	G	1465	A
1238 thru 1238C	H	1382	H	1466 thru 1466A	F
1239 thru 1243	J	1383 thru 1383B	K	1467 thru 1468	K
1244 thru 1245A	K	1384 thru 1385	G	1471 thru 1471B	E
1246 thru 1247	J	1386	I	1472 thru 1472C	L
1248	H	1387 thru 1388	K	1473 thru 1473B	A
1249 thru 1251A	J	1389	G	1474	L
1252 thru 1254A	K	1390 thru 1390B	H	1475 thru 1476	A
1255	J	1391	K	1477	G
1256 thru 1262B	K	1392	J	1478	J
1263	J	1393	G	1479	G
1264 thru 1265E	K	1394 thru 1395A	P	1482 and 1482A	F
1266 thru 1267	G	1396	K	1483	F
1269 thru 1270D	K	1397	H	1484 thru 1484D	A
1271 thru 1271B	G	1398 thru 1399	K	1485	G
1272 thru 1275	K			1486	D
1276	H	1400	K	1487	J
1277 thru 1279D	K	1401 thru 1401F	F	1488 thru 1488D	A
1280	J	1402 and 1402B	G	1489 thru 1490B	C
1283 thru 1284D	K	1403A and 1403B	K	1491	L
1286 thru 1286A	H	1404 and 1404A	K	1493 and 1493A	G
1287	K	1405 thru 1406A	H	1494 and 1495A	B
1288	J	1407 thru 1408	K	1496	G
1289 thru 1289A	G	1409A	J	1497	A
1290 thru 1293A	K	1410 thru 1412A	I	1498	E
1294 thru 1295	J	1413 thru 1416	I	1499	F
1296 thru 1298	K	1417 and 1417A	K		
		1418 and 1418A	P	1500	E
1300 thru 1303	K	1419 and 1419A	K	1501A thru 1501E	A
1304 thru 1307	J	1420 and 1420A	H	1503 thru 1503D	L
1308 thru 1316A	K	1421 and 1421A	K	1506 thru 1507	F
1317 thru 1317B	J	1422 thru 1423	P	1508	G
1318 thru 1320B	K	1424	K	1509	C
1321 thru 1322	J	1425	G	1510	L
1323	K	1426 thru 1426B	P	1511	C
1325	G	1427 and 1427A	H	1512 and 1512A	B
1326 thru 1326F	K	1428 thru 1429A	P	1513	L
1327 thru 1327B	H	1430A	G	1515 thru 1516C	C
1328B and 1328C	K	1431	P	1517	E
1329	J	1432 and 1432A	G	1518	D
1330	H	1433	K	1519 thru 1521	A
1331	J	1434 thru 1435A	P	1522	L
1332	J	1436 and 1436A	I	1523	A
1333	I	1437	J	1524	B
1334	I	1439	I	1527	C
1343 thru 1344A	H	1440 thru 1440D	A	1528	A

Type Number-to-Letter Cross Reference Chart (cont.)

Type No.	Column Letter	Type No.	Column Letter	Type No.	Column Letter
1529A and 1529B	C	2045 thru 2046B	F	40069 thru 40075	N
1530 thru 1530B	A	2047 thru 2048	D		
1531 thru 1535B	C	2049 thru 2049A	F		
1536	L	2050 thru 2050A	D	710101 thru 710116	E
1537	A	2051 thru 2052A	D	710124 thru 710130	E
1538 thru 1541A	L	2053 thru 2055	F	710131 thru 710137	E
1542	E	2056	D	710138 thru 710149	E
1543 thru 1546	A	2057	F	710154	M
1547	C	2058 thru 2058B	D	710201 thru 710209	E
1549	C	2059 thru 2063	F	710210 thru 710218	E
		2064 thru 2064A	D	710219 thru 710227	E
S–1801 thru 1822	F	2065	F	710228	M
1823 and 1824	E	2066	D	710150	G
		2067 thru 2071B	F	710151	H
2001 thru 2003	B			710155	L
2004 thru 2006	D	2200 thru 2201A	D	710157	H
2007 thru 2007B	B	2202 thru 2204	E	710229	H
2008 thru 2008B	D	2205 thru 2205A	D	710230	N
2009	B	2206 thru 2206A	G	710234	N
2010 thru 2011	D	2207	D		
2012	F	2208	G	200.183112	F
2013 thru 2014	B	2768	C	200.18322	F
2015 thru 2018	D			200.193132	F
2020	F	40001 thru 40028	N	200.193142	F
2021	D	40029 thru 40032C	O	200.193152	G
2022 thru 2022B	F	40033	N	200.193162	G
2023 thru 2026	D	40034 thru 40045A	O	200.203172	H
2027	B	40046	N	200.203182	H
2028 thru 2029	D	40047 thru 40052	O	200.203192	H
2030 thru 2031	B	40053 thru 40054A	N	200.213112	H
2032 thru 2033A	D	40056 thru 40060B	O	200.213122	H
2034 thru 2035C	F	40061 thru 40062B	N	200.503111	F
2036 thru 2037	B	40063 thru 40064	O	200.583111	F
2038	F	40065 thru 40066	N	200.593121	F
2039 thru 2044	C	40067 thru 40068	O	200.613111	F

Specifications for 2 Cycle Engines with Split Crankcases

	A	B	C	D	E	F	G	H
Bore	1.500 1.5005	1.6253 1.6258	1.7503 1.7508	1.7503 1.7508	2.000	2.000	2.000	2.000
Stroke	1.375	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Displacement Cubic Inches	2.43	3.10	3.60	3.60	4.70	4.70	4.70	4.70
Point Gap	.020	.020	.020	.020	.020	.020	.015	.015
Timing B.T.D.C. Before Top Dead Center	1/16" or .0625	5/32" or .1562	5/32" or .1562	1/4" or .250	5/32" or .1562	5/32" or .1562	5/32"	1/4" or .250 11/64" for "super"
Spark Plug Gap	.030	.030	.030	.030	.030	.030	.030	.030
Piston Ring End Gap	.003 .008	.005 .010	.005 .010	.005 .010	.006 .011	.006 .011	.006 .011	.006 .011
Piston Diameter	1.4966 1.4969	1.6216 1.6219	1.7461 1.7464	1.7461 1.7464	1.9948 1.9951	1.9948 1.9951	1.9948 1.9951	1.9949 1.9955
Piston Ring Groove Width	.095 .096	.095 .096	.095 .096	.095 .096	.095 .096	.095 .096	.095 .096	.095 .096
Piston Ring Width	.093 .0935	.093 .0935	.093 .0935	.093 .0935	.093 .0935	.093 .0935	.093 .0935	.093 .0935
Piston Pin Diameter	.3750 .3751	.3750 .3751	.3750 .3751	.3750 .3751	.3750 .3751	.3750 .3751	.3750 .3751	Early .3750 .3761 Late .4997 .4999
Connecting Rod Diameter Crank Bearing	.6869 .6874	.6869 .6874	.6869 .6874	.6986 .6989 w/o needles	.6869 .6874	.6869 .6874	.6869 .6874	.6935 .6939 w/o needles
Crankshaft Rod Needle Diameter				.0653 .0655				.0653 .0655
Crank Pin Journal Diameter	.6860 .6865	.6860 .6865	.6860 .6865	.5615 .5618	.6860 .6865	.6860 .6865	.6860 .6865	.5615 .5618
Crankshaft P.T.O. Side Main Brg. Dia.	.6689 .6693	.6689 .6693	.6690 .6694	.6689 .6693	.9995 1.0000	.6689 .6693	.9995 1.0000	.9995 1.0000
Crankshaft Magneto Side Main Brg. Dia.	.6689 .6693	.6689 .6693	.6689 .6693	.6690 .6694	.7495 .7500	.6689 .6693	.7495 .7500	.7495 .7500
Crankshaft End Play	.003 .008	.003 .008	.003 .008	.003 .008	.009 .022	.009 .022	.009 .022	.009 .022

Specifications for 2 Cycle Engines with Split Crankcases (cont.)

I	J	K	L	M	N	O	P	
2.000	2.000	2.093 2.094	2.2505 2.2510	2.2505 2.2510	2.5030 2.5035	2.5030 2.5035	2.000	Bore
1.50	1.625	1.63	2.00	2.00	1.625	1.680	1.50	Stroke
4.70	5.10	5.80	8.00	8.00	7.98	8.25	4.70	Displacement Cubic Inches
.015	.020	.015	.020	.020	.020	.020	.015	Point Gap
11/64" or .175	11/64" or .175	3/32" or .095	1/8" or .125	3/32" or .095	11/64" or .175	11/64" or .175	.90	Timing B.T.D.C. Before Top Dead Center
.035	.030	.030	.030	.030	.030	.030	.035	Spark Plug Gap
.006 .011	.006 .011	.006 .011	.007 .015	.007 .015	.005 .013	.005 .013	.006 .011	Piston Ring End Gap
1.9948 1.9951	1.9951 1.9948	2.0880 2.0883	2.2460 2.2463	2.2460 2.2463	2.4960 2.4963	2.4960 2.4963	1.9948 1.9951	Piston Diameter
.095 .096	.095 .096	T.0655 .0665 L.0645 .0655	.095 .096	.095 .096	T.0655 .0665 L.0645 .0655	T.0655 .0665 L.0645 .0655	.095 .096	Piston Ring Groove Width
.093 .0935	.093 .0935	.0615 .0625	.093 .0935	.093 .0935	.0615 .0625	.0615 .0625	.093 .0935	Piston Ring Width
.4997 .4999	.3750 .3751	.4997 .4999	.5000 .5001	.3000 .5001	.4997 .4999	.4997 .4999	.4997 .4999	Piston Pin Diameter
.6941 .6944	.6869 .6874	.9407 .9412	1.000 1.0004	1.000 1.0004	.9407 .9412	.9407 .9412	.6941 .6944	Connecting Rod Diameter Crank Bearing
.0653 .0655		.0943 .0945	.0943 .0945	.0943 .0945	.0943 .0945	.0943 .0945	.0653 .0655	Crankshaft Rod Needle Diameter
.6860 .6865	.6860	.7499 .7502	.8096 .8099	.8096 .8099	.7499 .7502	.7499 .7502	.6860 .6865	Crank Pin Journal Diameter
.9995 1.0000	.9995 1.0000	.6990 .6994	.9839 .9842	.9839 .9842	.7871 .7875	.7871 .7875	.9995 1.0000	Crankshaft P.T.O. Side Main Brg. Dia.
.7495 .7500	.7495 .7500	.6990 .6994	.9839 .9842	.9839 .9842	.7498 .7501	.7498 .7501	.7495 .7500	Crankshaft Magneto Side Main Brg. Dia.
.009 .022	.009 .022	.003 .008	.003 .008	.003 .008	.008 .013	.008 .013	.009 .022	Crankshaft End Play

Uniblock Cross Reference Chart

Type No.	Column No.
Vertical Crankshaft Engines	
638 thru 638–100	6
642–01, A	9A
642–02, A, B, C, D	9A
642–02E, F	9B
642–03, A, B	9A
642–04, A, B, C	9A
642–05, A, B	9A
642–06, A	9A
642–07, A, B	9A
642–07C	9B
642–08	9B
642–08A, B	9A
642–09 thru 642–14	9A
642–13A, 14A, 14B	9B
642–15 thru 642–22	9B
642–24 thru 642–30	9C
670–01 thru 670–101	8
200–183112	6
200–183122	6
200–193132	6
200–193142	6
200–193152	7
200–193162	7
200–203172	8
200–203182	8
200–203192	8
200–213112	8
200–213122	8
200–243112	8
200–283012	8

Type No.	Column No.
Horizontal Crankshaft Engines	
1401 thru 1401F	16
1401G, H	17
1401J	27
1402 and 1402B	7
1425	7
1430A	7
1432 and 1432A	7
1440 thru 1440D	1
1442 thru 1442B	7
1444 and 1444A	7
1448 thru 1450	16
1450A thru 1450B	16
1450C thru 1450E	16
1450F	17
1454 and 1454A	1
1459	7
1460 thru 1460F	1
1462	1
1464 thru 1464B	12
1465	1
1466 thru 1466A	16
1471 thru 1471B	5
1472 thru 1472C	12
1473 thru 1473B	1
1474	12
1475 thru 1476	1
1479	7
1482 and 1482A	16
1483	16
1484 thru 1484D	3
1485	7
1486	4
1488 thru 1488D	1
1489 thru 1490B	3
1491	12
1493 and 1493A	7
1494 and 1495A	2
1496	7
1497	1
1498	5
1499	16
1500	5
1501A thru 1501E	1
1503 thru 1503D	12
1506	16
1506B	17
1507	16

Type No.	Column No.
Horizontal Crankshaft Engines	
1508	7
1509	3
1510	12
1511	3
1512 and 1512A	2
1513	12
1515 thru 1516C	3
1517	5
1518	4
1519 thru 1521	1
1522	12
1523	1
1524	2
1525A	16
1527	3
1528	1
1529A and 1520B	3
1530 thru 1530B	1
1531	3
1534A	17
1535B	3
1536	12
1537	1
1538 thru 1541A	12
1542	5
1543 thru 1546	1
1517	3
1519	3
1551	16
1552	20
1553	16
1554 and 1554A	3
1555 and 1556	16
1561	19
1572	2
1573	3
1574 thru 1577	23
1575	24
1578	25
1581 thru 1582A	23
1583 thru 1595	26
200–503111	16
200–583111	16
200–593121	16
200–613111	16
200–672102	26
200–682102	26

Torque Specifications for 2-Cycle Engines

Application	Torque
Carburetor and Reed Plates	
Carburetor to crankcase, Carburetor to adapter, or Carburetor adapter to crankcase	70–75 in. pounds
Carburetor to snow blowers cover	30–35 in. pounds
Carburetor outlet fitting	40 in. pounds
Reed and cover plates 639 type engines	50–60 in. pounds with Loctite, type A
Reed to plate 635 type engines	12–18 in. pounds
Crankcase and Cylinder	
Crankcase to crankcase cover	23–30 in. pounds
Crankcase to crankcase cover screws	35–40 in. pounds
Mounting cylinder or carburetor to crankcase studs	50 in. pounds
Base to crankcase	240–250 in. pounds
Cylinder to crankcase nuts	70–75 in. pounds
In cylinder	100–110 in. pounds
Spark plug stop lever and head shroud to head	50–60 in. pounds
Cylinder head to cylinder	30–40 in. pounds
Cylinder head to cylinder	50–60 in. pounds 80–90 in. pounds
Cylinder head to cylinder (635 type engine)	45–50 in. pounds
Cable clip and transfer port cover to cylinder	25–30 in. pounds
Cable clip to cylinder Stop lever to cylinder	25–30 in. pounds
Spark plug	18–22 ft. pounds
Transfer cover cross port engines	25–30 in. pounds
Crankshaft and Connecting Rods	
Aluminum and bronze rods to rod cap	40–50 in. pounds
Steel rod to rod cap	70–80 in. pounds
Flywheel nut on tapered end of crankshaft: Aluminum hub on iron or steel shaft.	18–25 ft. pounds
Steel hub flywheel on iron shaft	18–25 ft. pounds
Steel hub flywheel on steel shaft	30 ft. pounds
Governor and Bell Crank Parts	
Power take-off end governor lower ring to crankshaft setscrew	30–35 in. pounds
Bell crank bracket to crankcase	20–25 in. pounds
Governor cover to crankcase	50–60 in. pounds

Specifications Chart

	1	2	3	4	5	6	7	8	9A	9B	9C	12
Bore	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094
Stroke	1.250	1.410	1.410	1.410	1.410	1.500	1.500	1.500	1.500	1.500	1.500	1.410
Cu. In. Displacement	4.40	4.80	4.80	4.80	4.80	5.20	5.20	5.20	5.20	5.20	5.20	4.80
Point Gap	.017	.017	.017	.017	.017	.018	.017	.020	.018	.020	.020	.017
Timing B.T.D.C.	.122″	.100″	.135″	.100″	.135″	.100″	.185″	.070″	.110″	.085″ See Note 1	.078″ See Note 2	.135″
Spark Plug Gap	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035
Piston Ring End Gap	.007 .017	.007 .017	.006 .011	.006 .014	.006 .011	.006 .014	.007 .017	.006 .016	.007 .017	.006 .016	.006 .016	.007 .017
Piston Diameter	2.0080 2.0870	2.0880 2.0870	2.0885 2.0875	2.0885 2.0875	2.0885 2.0875	2.0880 2.0870	2.0880 2.0870	2.0880 2.0870	2.0880 2.0870	2.0880 2.0820	2.0880 2.0870	2.0880 2.0870
Piston Ring Groove Width (Top)	.0655 .0665	.0655 .0665	.0655 .0665	.0975 .0985	.0655 .0665	.0975 .0985	.0655 .0665	.0655 .0665	.0655 .0665	.0655 .0665	.0655 .0665	.0655 .0665
Piston Ring Groove Width (Bot.)	.0645 .0655	.0645 .0655	.0645 .0655	.0955 .0965	.0645 .0655	.0955 .0965	.0645 .0655	.0645 .0655	.0645 .0655	.0645 .0655	.0645 .0655	.0645 .0655
Piston Ring Width	.0625 .0615	.0625 .0615	.0625 .0615	.0925 .0935	.0625 .0615	.0925 .0935	.0625 .0615	.0625 .0615	.0625 .0615	.0625 .0615	.0625 .0615	.0625 .0615

Piston Pin Diameter	.4999 .4997	.4999 .4997	.4999 .4997	.3750 .3751	.4999 .4997	.3750 .3751	.4999 .4997	.4999 .4997	.4999 .4997	.4999 .4997	.4999 .4997	.4999 .4997
Connecting Rod Diameter Crank Bearing	—	—	—	.6886 .6879 Dowels	—	—	—	1.0053 1.0023 Liner Dia.	—	1.0053 1.0023 Liner Dia.	1.0053 1.0023 Liner Dia	—
Crankshaft Rod Needle Dia.	.0655 .0653	.0655 .0653	.0655 .0653	—	.0655 .0653	—	.0655 .0653	.0781 .0780	—	.0781 .0780	.0781 .0780	.0655 .0653
Crank Pin Journal Diameter	.5618 .5611	.5621 .5614	.5621 .5614	.6865 .6857	.5618 .5611	.6865 .6857	.5618 .5611	.8450 .8442	.6865 .6857	.8450 .8442	.8450 .8442	.5621 .5614
Crankshaft P.T.O. Side Main Brg. Dia.	.6695 .6691	.6695 .6691	.6695 .6691	.6695 .6691	.6695 .6691	.8750 .8745	.6694 .6690	1.0003 .9998	.8750 .8745	1.0003 .9998	1.0003 .9998	.6695 .6691
Crankshaft Magneto Side Main Brg. Dia.	.6695 .6691	.6695 .6691	.6695 .6691	.6695 .6691	.6695 .6691	.7500 .7495	.6694 .6690	.6695 .6691	.7500 .7495	.7503 .7498	.6695 .6691	.6695 .6691
Crankshaft End Play	None	None	None	None	None	.003 .016	None	None	.003 .016	.003 .016	None	None

NOTE 1: 642-08 14A, 14B B.T.D.C. = .110″
642-16D, 19A, 20A, 21 22 B.T.D.C. = .078″
NOTE 2: 642-24, 26, 29 B.T.D.C. = .085″
643-2a, 25, 26 B.T.D.C. = .085″
NOTE 3: 643-13 B.T.D.C. = .095″
NOTE 4: 643-03A, 05A, 13, 14 = .020″

Specifications Chart

	14	16	17	19	20	23	24	25	26	27
Bore	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094	2.093 2.094
Stroke	1.500	1.500	1.500	1.410	1.250	1.500	1.410	1.410	1.500	1.500
Cu. In. Displacement	5.20	5.20	5.20	4.80	4.40	5.20	4.80	4.80	5.20	5.20
Point Gap	.018	.017	.017	.017	.017	.017	.017	.020	.020	.017
Timing B.T.D.C.	.100″	.110″	.110″	.100″	.122″	.110″	.135″	Fixed	.062″	.100″
Spark Plug Gap	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035
Piston Ring End Gap	.006 .014	.006 .016	.006 .016	.007 .017	.007 .017	.006 .016	.007 .017	.007 .017	.006 .016	.006 .016
Piston Diameter	2.0880 2.0870	2.0885 2.0875	2.0890 2.0880	2.0880 2.0870	2.0880 2.0870	2.0880 2.0870	2.0880 2.0870	2.0880 2.0870	2.0880 2.0870	2.0885 2.0875
Piston Ring Groove Width (Top)	.0975 .0985	.0645 .0655	.0645 .0655	.0655 .0665	.0655 .0665	.0655 .0665	.0655 .0665	.0655 .0665	.0655 .0665	.0655 .0665
Piston Ring Groove Width (Bot.)	.0955 .0965	.0645 .0655	.0645 .0655	.0645 .0655	.0645 .0655	.0645 .0655	.0645 .0655	.0645 .0655	.0645 .0655	.0645 .0655

Piston Ring Width	.0925 .0935	.0625 .0615	.0625 .0615	.0625 .0615	.0625 .0615	.0625 .0615	.0625 .0615	.0625 .0615	.0625 .0615	.0625 .0615
Piston Pin Diameter	.3750 .3751	.3750 .3751	.4999 .4997	.4999 .4997	.4999 .4997	.4999 .4997	.4999 .4997	.4999 .4997	.4999 .4997	.4999 .4997
Connecting Rod Diameter Crank Bearing	—	—	—	—	—	.8534 .8504 Liner Dia.	—	—	.8534 .8504 Liner Dia.	.8919 .8924
Crankshaft Rod Needle Dia.	—	—	—	.0655 .0653	.0655 .0653	.0781 .0780	.0655 .0653	.0655 .0653	.0781 .0780	.0781 .0780
Crank Pin Journal Diameter	.6965 .6857	.6868 .6857	.6865 .6857	.5621 .5614	.5618 .5611	.6927 .6919	.5621 .5614	.5621 .5614	.6927 .6919	.6927 .6922
Crankshaft P.T.O. Side Main Brg. Dia.	.8750 .8745	.6695 .6691	1.0003 .9998	.6695 .6691	.6695 .6691	.6695 .6691	.6695 .6691	.6695 .6691	.7503 .7498	.6695 .6691
Crankshaft Magneto Side Main Brg. Dia.	.7500 .7495	.7500 .7495	.7500 .7495	.6695 .6691	.6695 .6691	.7503 .7498	.6695 .6691	.6695 .6691	.6695 .6691	.7503 .7498
Crankshaft End Play	.003 .016	None	None	None	None	None	None	None	None	.003 .016

A. on Engines prior to 660-24: 7505, 7198

11

Wisconsin Robin

IDENTIFICATION

There is an identification plate attached to the upper blower housing which lists the engine model on the left and individual engine serial number on the right. Both of these should be used when requesting parts.

General Engine Specifications

Model	Bore & Stroke (in.)	Displacement (cu in.)	Horsepower @ RPM
EY18W	2.56 x 2.16	11.14	4.6 @ 3,600

MAINTENANCE

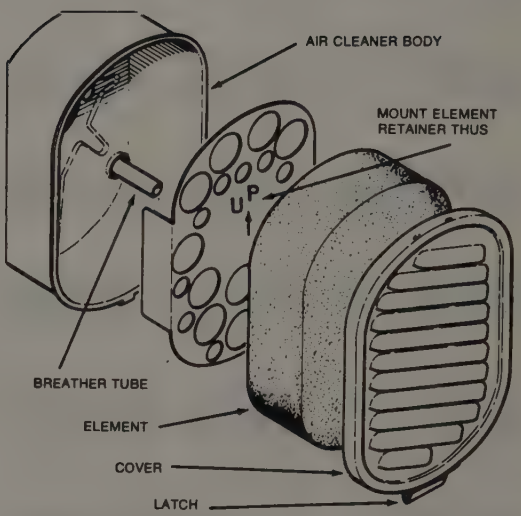
Air Cleaner

SERVICE

The air cleaner should be serviced every 50 hours in normal operation, more often (daily) if the air is dusty.

First disassemble the unit as follows:

1. Remove the air cleaner cover, element and element retainer.
2. Disconnect the breather tube from the inspection cover.
3. Remove the two capscrews and remove the air cleaner body and gasket from the carburetor.
4. Wipe all metal parts clean. Wash the element *only* in either kerosene, or water and a liquid detergent. Do not wash in any other solvents.
5. Wrap the element in a cloth and squeeze it dry.
6. Pour engine oil into the filter until it is saturated, and then squeeze out the excess.
7. Reassemble in reverse of above. Make sure element retainer is installed with arrow up.



Exploded view of air cleaner

Lubrication

OIL AND FUEL RECOMMENDATIONS

Oil

Use only MS or SD oils of the viscosity shown in the chart for both normal operation and breakin. See chart for crankcase capacities.

Oil Viscosity Chart

Season or Temperature	Grade of Oil*
Spring, Summer or Autumn (+120°F to +40°F)	SAE 30
Winter	
(+40°F to +15°F)	SAE 20
(Below +15°F)	SAE 10W-30

*Use oils classified as Service MS or SD

Crankcase Capacity	
Model	Capacity (pts.)
EY18W	1.25

Fuel

Use only regular grade gasoline with an octane rating of 90 or above. Use only a reputable brand of fuel, and make sure it is free of both dirt and water. Note that low octane fuel may cause the engine to detonate and result in severe damage. Do not use gasoline that is more than one month old.

TUNE-UP

Spark Plug

The spark plug should be checked frequently for fouling, widened or otherwise improper gap, or more serious problems such as eroded electrodes or a cracked insulator. Clean carbon deposits from the electrodes with a wire brush, and set the gap to .020–.025 in. with a wire type feeler gauge. Bend only the side electrode. If electrodes are severely eroded so that the side electrode has lost its sharp, rectangular cross-section or the center electrode is very short, or if there are any cracks in the insulator, the spark plug should be replaced.

Always check the plug gap before installation, even if the plug is new. Install the plug with a new gasket and torque it to 24–27 ft. lbs.

Breaker Points

REMOVAL AND INSTALLATION

1. Remove the three mounting screws and remove the starter pulley. Install a 14 mm socket wrench onto the flywheel nut and tap the wrench sharply with a soft hammer. If you have a wheel puller, remove the nut. Otherwise, unscrew it until it is flush with the end of the crankshaft.
2. Remove the flywheel with a wheel puller or as follows:
3. Place a large screwdriver between the crankcase and the flywheel. The screwdriver must be in line with the keyway. While wedging the flywheel outward with the screwdriver, strike the outer end of the flywheel nut with a soft (brass, wood or plastic) hammer. This will bring the flywheel off the crankshaft taper.
4. Take off the point cover by removing mounting screws and pulling it off. Unscrew the terminal nut connecting condenser and coil wires to the contact set, and disconnect the wires. Remove the contact lockscrew, and remove the contacts.
5. Position the pin contacts on the crankcase, install the lockscrew, and tighten it just slightly.

Tune-Up Specifications

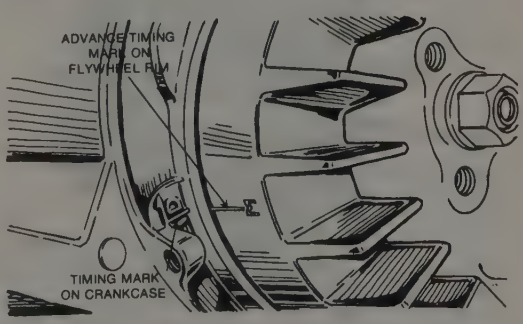
Model	Plug Type	Plug Gap (in.)	Point Gap (in.)	Ignition Timing (deg Before Top Center)
EY18W	①	.020–.025	.014	23

① 14 mm. Champion L86,
AC 44F
NGK B6HS

6. Adjust the contact gap and time the engine as described below.

SETTING POINT GAP AND IGNITION TIMING

1. If necessary, remove the flywheel and point cover as described in steps 1–4 above. Loosen the contact lockscrew.
2. Turn the engine over until the contact cam follower is at the very peak of the cam. Using a flat .014 feeler gauge, slide the points back and forth via the adjusting knob until the gauge just slides between the contact surfaces. Tighten the contact lockscrew. Recheck gap and, if necessary, reset it.
4. Connect a timing light between the coil primary ground. Align the "M" timing mark on the rim of the flywheel with the "D" mark on the lower left side of the crankcase by rotating the flywheel. See illustration.
5. Turn the flywheel counterclockwise slowly until the light either goes on or goes off, depending on the type. Turn it very slowly clockwise *just* until the light reacts again. If the timing marks are aligned, timing is correct. If the "M" mark is below the "D" mark (the "D" is on the crankcase), the breaker gap is too large; if the "M" is above the "D", the breaker gap is too small. Reset the contact gap as necessary. If timing is off about 2 degrees or ⅛ in. of flywheel rotation, the gap must be changed about .001 in.
6. Reset the contact gap and recheck timing until timing is correct.



Aligning ignition timing marks

7. Remove the timing light and install the timing cover and flywheel. In installing the flywheel, slide it into place with key and keyway aligned, and then install retaining nut and tighten it just until lockwasher collapses. Finally, put a wrench on the nut and tap it lightly once or twice, or torque the nut to 44–47 ft. lbs. with a torque wrench.

Magneto Service

1. If the engine is hard to start or runs erratically, first service the spark plug. If this does not cure the problem, remove the flywheel and check for loose or broken ignition wires. Inspect the points. See "Breaker Point Removal and Installation," above. Repair the wires or replace the points and condenser. Set the point gap and timing, as required.

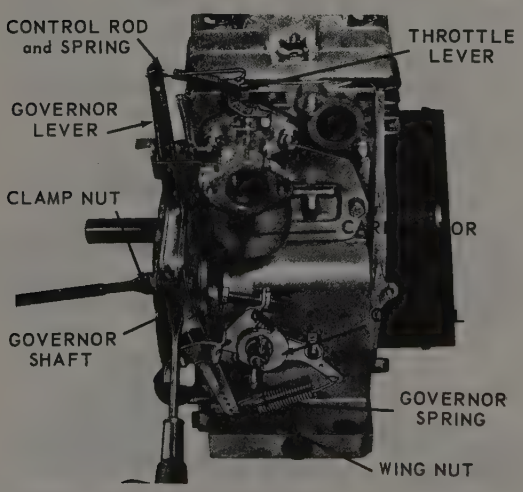
2. Check the spark by removing the plug and grounding it against the engine block with the high tension wire connected. Then, spin the engine. If the spark is erratic or weak, remove the ignition coil by removing the flywheel, feeding the high tension wire through the grommet in the wall of the cylinder block, disconnecting the primary wire, and removing the mounting screws and coil. Replace the coil in reverse of the above.

Governor Adjustment

If the governor lever has been loosened or removed, perform the governor lever adjustment. Otherwise, skip to "Speed Regulation," below.

GOVERNOR LEVER ADJUSTMENT

1. Mount the governor lever with the clamp screw just slightly loose.



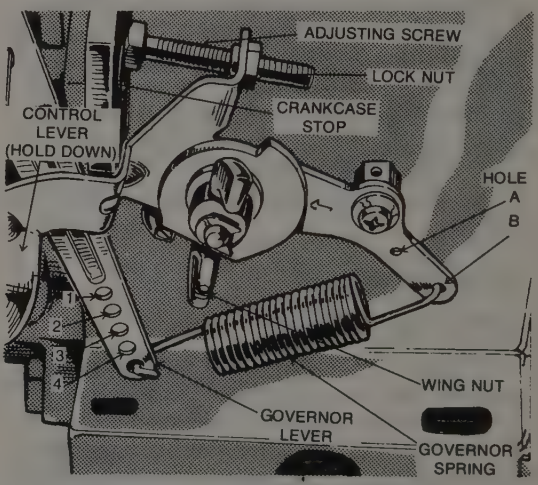
Adjusting the governor lever

2. Install both the control rod and spring which connect the governor lever and the throttle lever. Mount the control lever assembly onto the crankcase but do not tighten the wingnut.

3. Connect the governor spring between the holes of both governor lever and control lever as shown in the illustration below.

4. Turn the control lever counterclockwise until the throttle in the carburetor is fully open. Lock the lever in this position by tightening the wingnut.

5. With the clamp screw loose so the governor shaft will turn independently of the governor lever, turn the governor shaft (use a screwdriver in the groove in the end of the shaft) until you can feel the internal vane stop against the flywheel thrust sleeve (this is as far as the shaft can be turned without excessive force). Tighten the lever clamp nut.



Adjusting governor speed

SPEED REGULATION

1. Remove the load from the engine, and run it until it is hot.

2. Install the governor spring hooked to holes "1" and "B" as shown above.

3. Loosen vhe control lever wing nut so that the lever is free to move. Loosen the locknut on the adjusting screw. Find the desired no-load speed on the chart above that corresponds with the speed at which you want the engine to run when fully loaded.

4. Hold the control lever down so the adjusting screw is against the crankcase stop. Turn the adjusting screw in or out until the required no-load speed is obtained. Tighten the adjusting screw locknut.

5. If the engine is to operate at a fixed speed, tighten the control lever wingnut.

Governor No-Load/Load RPM Chart

Load RPM	No Load RPM EY18W	Spring Holes EY18W
1800	2370	1-B
2000	2515	1-B
2200	2665	1-B
2400	2815	1-B
2600	2975	1-B
2800	3140	1-B
3000	3310	1-B
3200	3485	1-B
3400	3670	1-B
3600	3855	1-B

Carburetor

OVERHAUL

1. Using the illustration as a guide, remove the choke phillips head screws (17), and then take out the choke valve and shaft (18 and 19).

2. Remove the choke shaft retainer spring and ball (30 an 31) to prevent their being lost (these are used on models EY25W and EY27W).

3. Remove the throttle plate phillips head screws (17) and take out the choke valve and shaft (18 and 19), being careful not to damage the edges of the throttle valve.

4. Remove the throttle stop screw and spring (14 and 25).

5. Remove the main jet holder (16) and then take off the float bowl (13).

6. Remove the main jet from the (15) jet holder.

7. Remove the main nozzle (9) from the carburetor body.

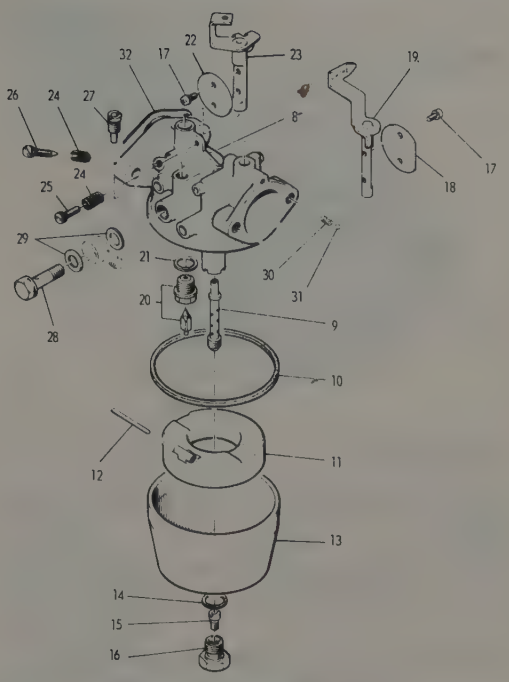
8. Remove the idle jet (27) *using an appropriate tool* to prevent damage to it.

9. Remove the float pin (12), float (11), and needle valve (20).

10. Inspect the float. Replace it if dented, fuel has leaked in, or if the float hinge pin or the tab that limits float travel is worn.

11. Clean all parts thoroughly in a solvent such as Bendix Metalclene or Speeclene, rinse in a cleaning solvent, and blow out all passages with low pressure compressed air in the reverse direction of normal flow. Make sure all carbon deposits have been removed from the throttle bore and idle discharge holes.

NOTE: *Never use a drill or wire to clean jets!*



Carburetor—exploded view

12. Reassemble, keeping the following points in mind:

A. Replace the needle valve and seat with a matched valve and seat (as included in a repair kit).

B. Install the new idle jet and adjusting screw which are included in the repair kit. Make sure the idle jet is tightened firmly.

C. Install the new main jet, tighten securely, and then install the main jet holder and torque to 5.5 ft. lbs.

D. When assembling the choke, make sure the flat on the choke valve faces the main air jet.

ENGINE OVERHAUL

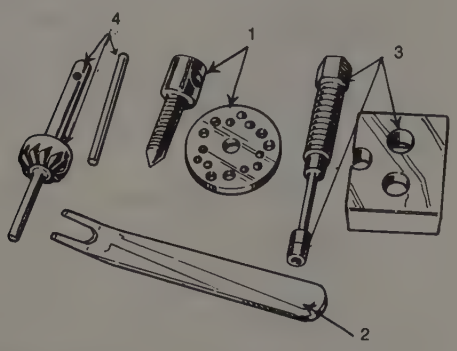
Tools

To overhaul this engine, which uses metric fasteners, you should have the following tools:

1. 10 mm thin wall socket
2. 10 mm standard socket
3. 10 mm deep socket
4. 12, 14 and 18 mm standard sockets.
5. 10, 12, and 14 mm open end wrenches.

In addition, various special pullers, a valve spring compressor, and a valve set cutter are required. See the illustration. Wisconsin-Robin part numbers are provided for your use in ordering the tools either from them or from a tool manufacturer who makes equivalent tools which are cross-referenced.

The tools and Wisconsin-Robin part numbers are listed below:



Special tools

Reference Number	Part Number	Part Name
1.	EYY790-350	Flywheel Puller
	EY016508500	Bolt, 8 x 50 mm (3 required)
2.	EYY790-282	Valve Spring Compressor
3.	EYY790-324 (for 18W engine)	Valve Guide Puller
	EYY790-524 (for 25W, 27W engines)	Valve Guide Puller
4.	EYH640-118	Seat Cutter (45°)

Engine Disassembly, Reassembly, and Overhaul

Engine disassembly instructions are provided below, in proper sequence. Reassembly is primarily a simple reversal of disassembly. Notes on the extra procedures to be performed as the engine is put back together are included with the disassembly instructions for each part of the engine.

FUEL TANK

1. Disconnect the fuel line at the carburetor. Note that in reassembly, it is advisable to use a new fuel line.
2. Remove the fuel tank from the bracket.
3. Remove the tank bracket from the cylinder head.
4. In reassembly, wash the element per "Air Cleaner Service" instructions above, and correctly mount the element retainer as illustrated there.

FLYWHEEL SHROUD

1. Disconnect the coil primary wire from the stop button wire.
2. Remove the flywheel shroud from the cylinder-case, and the baffle from the head.
3. Remove the baffle from the cylinder block.

AIR CLEANER

1. Remove the air cleaner cover, element and element retainer.
2. Disconnect the breather tube from the inspection cover.
3. Remove the two capscrews and remove the air cleaner body and gasket from the carburetor.

MUFFLER

Remove the two hex nuts and remove the muffler and gasket from cylinder-case.

GOVERNOR LEVER AND CARBURETOR

1. Disconnect the governor spring from the lever and speed control assembly.
2. Remove the governor lever from the shaft, and, at the same time, disconnect the rod and spring from the lever and carburetor.
3. Remove the two nuts and lockwashers, and remove the two nuts and lockwashers, and remove the carburetor, insulating plate and gaskets from the cylinder-case.
4. If necessary, the speed control assembly can be removed from the side of the crankcase by removing the wing nut and clip.
5. *In reassembly,* refer to "Governor Adjustment" above.

STARTING PULLEY AND FLYWHEEL

1. To remove the starting pulley, first remove the three mounting screws.
2. Place a 14 mm socket wrench on the flywheel nut and give the wrench a sharp blow with a soft hammer. Remove the nut, spring washer and pulley.
3. Attach puller to flywheel—turn center bolt clockwise until flywheel becomes loose enough to be removed. *If puller is not available,* screw flywheel nut flush with end of crankshaft to protect shaft threads from being damaged. Place the end of a large screwdriver between the crankcase and flywheel in line with the keyway. Then, strike the end of the flywheel nut with a babbitt or other soft hammer and at the same time wedge outward with the screwdriver.
4. Disconnect the high tension cable from the spark plug, and slip the cable along with the rubber grommet through the hole, to the inside of the crankcase. Then remove the ignition coil along with the attached high tension cable by taking out the two mounting screws, and disconnecting the breaker assembly wire.

5. Remove the contact breaker and condenser by removing the point cover, and removing mounting screws from the cylinder case. Slip the coil primary wire along with the grommet through the hole in the side of the crankcase.

6. *In reassembly,* refer to "Setting Point Gap and Timing."

7. Securely tighten the flywheel nut after the timing is finalized, but first be sure the woodruff key is in position on the shaft. *Do not* drive the flywheel onto the taper of the crankshaft and *do not* overtighten the flywheel nut. Simply turn the nut until the lockwasher collapses. Then, tighten it by placing a wrench on the nut and giving the handle of the wrench 1 or 2 sharp blows with a soft hammer. If a torque wrench is available, tighten to *44* to *47 ft. lbs.*

CYLINDER HEAD AND SPARK PLUG

1. Remove the spark plug from the cylinder head.

2. Loosen the mounting nuts and remove the cylinder head along with the gasket.

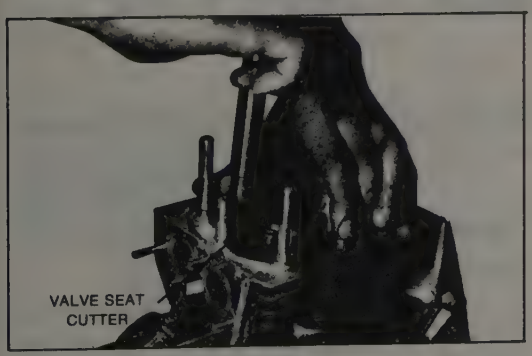
3. Clean the carbon from the combustion chamber and the dirt from among the cooling fins. Check the cylinder head mounting face for distortion. If *warpage* is evident, replace head.

4. *In reassembly,* use a new cylinder head gasket and spark plug. *Torque* the head nuts to *22 ft. lbs.* Leave the spark plug out temporarily, for each in turning engine over for the remainder of assembly and for timing adjustments. When installing the spark plug, tighten it *24* to *27 ft. lbs. torque.*

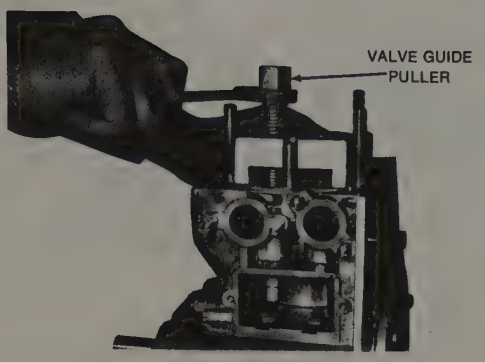
INTAKE AND EXHAUST VALVES

1. Remove the valve inspection cover, breather plate and gaskets from the cylindercase.

2. Lift the valve springs, by means of a compressor tool *EYY790-282* or equivalent and remove the retainer locks with long nose pliers. Release the compressor tool and remove the intake valve and exhaust valve along with their respective spring and retainer. A standard Automotive type valve lifter can be used for removing valves, but is not practical for reassembly.



Correcting the valve seats



Pulling out valve guides with special tool

CAUTION: *Do not damage the gasket surface of the tappet chamber with the compressor tool.*

3. Clean carbon and gum deposits from the valves, seats, ports and guides.

4. *In reassembly,* replace valves that are badly burned, pitted or warped.

5. Correct the valve seat by using a *45°* seat cutter tool No. *EYH640-118* or equivalent as illustrated. The finished seat width should be *0.047* to *0.059 in.*—maximum usable width is 0.098 in.

CAUTION: *Do not use an electric power driven grinding wheel to correct the valve seats.*

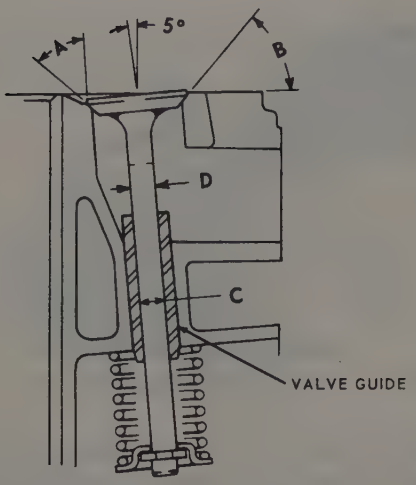
6. *Valve guides* should be replaced when the valve stem clearance becomes excessive. Use a valve guide puller tool *EYY790-324* or equivalent. *See* illustration. Draw the valve guides out and press new guides in using the same puller tool. Refer to the illustration for clearance specifications and proper assembly.

7. After correcting the valve seats and replacing the valve guides, lap the valves in place until a uniform ring will show entirely around the face of the valve. Clean the valves, and wash the block thoroughly with a hot solution of soap and water. Wipe the cylinder walls with clean, lint free rags and light engine oil. *Do not assemble the valve springs* until the tappet clearance has been checked. *See* "Tappet Adjustment" below.

TAPPET ADJUSTMENT

With the tappet in its lowest position, hold valve down and insert a feeler gauge between the valve and tappet stem. The clearance for both intake and exhaust, with the engine *cold* is:

- *0.006 to 0.008 in.*



A – VALVE FACE ANGLE	45°
B – SEAT ANGLE	45°
C – GUIDE INSIDE DIAMETER	0.2756 to 0.2770"
D – VALVE STEM DIAMETER	0.273 to 0.274"
MAXIMUM ALLOWABLE CLEARANCE BETWEEN C AND D	0.006"

Valve Specifications

If the clearance is less than it should be, grind the end of valve stem a very little at a time and remeasure. Stems must be ground square and flat.

If the clearance is too large, sink the valve seat with seat cutter tool.

After obtaining the correct clearance, assemble the valve springs and retainers, and secure them in place with the retainer locks. Check the operation of the valves by turning the crankshaft over by hand and remeasure the tappet clearance.

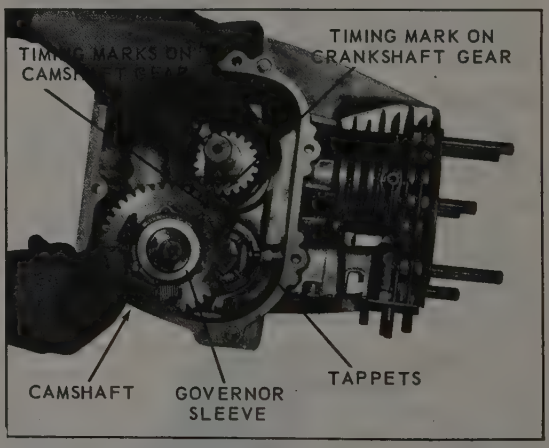
GEAR COVER AND CRANKSHAFT REMOVAL

1. Place a rag under the engine to absorb the remaining oil. Remove the gear cover mounting screws.
2. With a soft hammer, tap at even intervals around the outer surface of the gear cover until it breaks free of the crankcase face. Break the cover free carefully, so as to avoid damaging the oil seal.
3. Inspect the adjusting collar, oil seal, governor shaft and yoke. Replace any parts that are damaged or excessively worn.
4. Remove the flywheel woodruff key.
5. Pull the crankshaft out from open end of crankcase and take care not to damage the oil seal. If necessary, loosen shaft by tapping lightly at the flywheel end with a soft hammer.

NOTE: *The "Gear Cover and Crankshaft Installation" procedure is located with camshaft, connecting rod, and piston service, since that is the normal sequence of doing overhaul work.*

CAMSHAFT, TAPPETS AND TIMING MARKS

1. To prevent the tappets from falling out and becoming damaged when the camshaft is removed, turn the crankcase over on its side as shown. Push the tappets inward to clear the cam lobes, and remove the camshaft.
2. Withdraw the tappets and mark them for identification with the hole from which they were removed.
3. *In reassembly,* put the tappets back in their corresponding guide hole. This will eliminate unnecessary valve stem grinding for obtaining correct tappet clearance.
4. Mount governor sleeve on end of camshaft by holding the shaft in a vertical position with the flyweights hanging down. Align the groove in the flange with the pin in the gear face and install the sleeve on shaft so that its flange fits in the groove between the heavy end and the thrust tabs of all three flyweights. Mount camshaft assembly in crankcase.
5. The *timing marks* on the camshaft gear and crankshaft gear must be matched up. Mount the camshaft so that the *marked tooth on crankshaft gear* is between the *two marked teeth* of the *camshaft gear, see* the illustration. If the valve timing is off, the engine will not function properly or may not run at all.



Postion in which engine should be placed while removing camshaft

CONNECTING ROD AND PISTON

Disassembly

1. Straighten out the bent tabs of the lock plate and remove the bolts from the connecting rod.

2. Remove lock plate, oil dipper and connecting rod cap.

3. Scrape off all carbon deposits that might interfere with the removal of the piston from the upper end of the cylinder. Use a ridge reamer.

4. Turn the crankshaft until the piston is at top, then push the connecting rod and piston assembly upward and out through the top of the cylinder.

5. Remove the piston from connecting rod by taking out one of the snap rings and then removing the piston pin. A new snap ring should be used in reassembly.

Reassembly

1. Use a ring expander tool to prevent the ring from becoming distorted or broken when installing on the piston.

2. If an expander tool is not available, install the rings by placing the open end of the ring on the first land of the piston. Spread the ring only far enough to slip it over the piston and into the correct groove, being careful not to distort the ring.

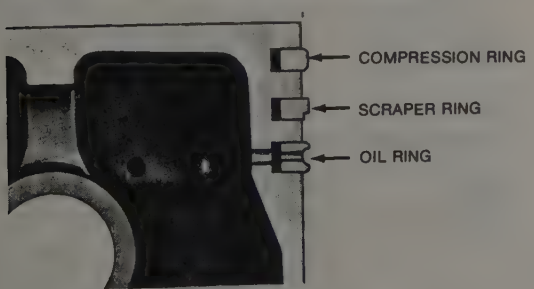
3. With the expander tool, assemble the bottom ring first and work upward, installing the top ring last.

4. Mount the scraper ring with the scraper edge down, otherwise oil pumping and excessive oil consumption will result. Refer to the illustration for correct placement of rings.

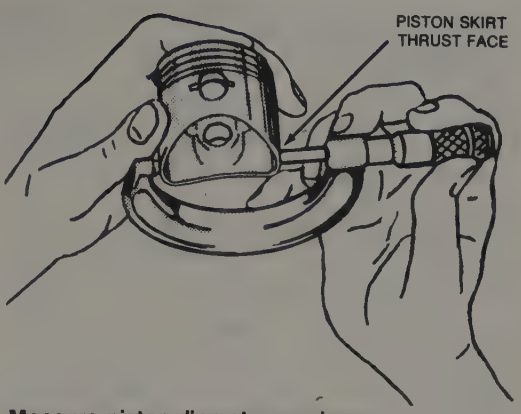
5. Measure the diameter of the piston in the center of the thrust faces at the bottom of the piston skirt, as illustrated.

6. Measure the cylinder bore and inspect it for out-of-round and taper. If the cylinder is scored or worn more than *0.005* inch over standard size, it should be rebored and fitted with an oversize piston and rings. Refer to the chart for the clearance between the piston and cylinder. Size, clearance and wear limits are given in more detail at the end of this chapter.

7. When installing the piston in the cylinder, oil the piston, rings, wrist pin, rod bearings and cylinder wall before assembly. Stagger the piston ring gaps 90° apart around the piston. Use a piston ring compressor.



Location and positioning of rings



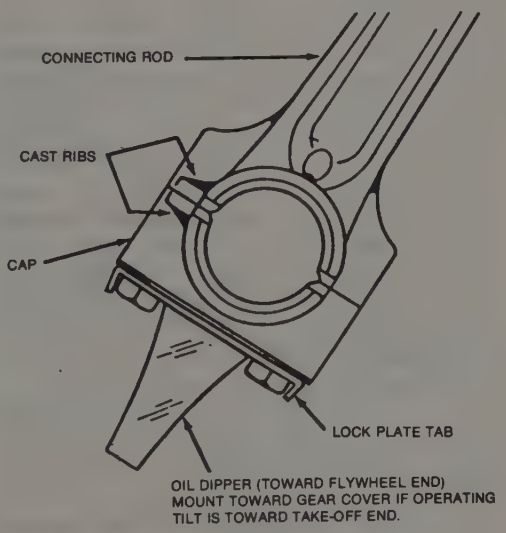
Measure piston diameter as shown

8. Turn the crankshaft to the bottom of the stroke and tap the piston down until the rod contacts the crank pin. Mount the connecting rod cap so that the *cast rib* between the face of rod and bolt boss matches up with the cast rib on the connecting rod. Assemble *oil dipper* to cap. The dipper should be *toward the gear cover* end of the connecting rod cap if engine is operated on a tilt toward the take off end. Mount the dipper toward the flywheel end if it's tilted in that direction or with a no tilt operation.

Install a new rod bolt lock plate. Mount the connecting rod bolts and tighten to the following torque specifications.

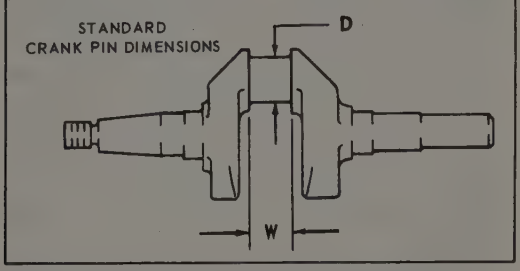
- Model EY18W *12.5 to 14.5 ft. lbs.*

Check for free movement of the connecting rod by turning the crankshaft over slowly. If satisfactory, bend the tabs on the lock plate against the hex head flat of the connecting rod bolts.

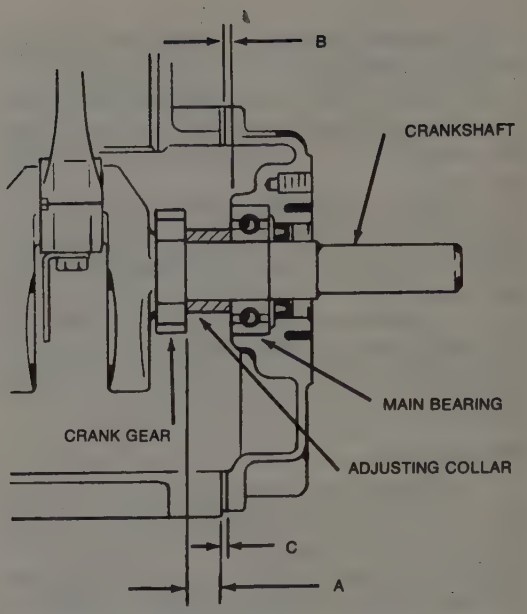


Connecting rod and oil dipper assembly

		EY18W
PISTON TO CYLINDER AT PISTON SKIRT THRUST FACE		.0016 .0032"
CONNECTING ROD TO CRANK PIN	DIA.	.0021 .0031"
	SIDE	.008 .0235"
PISTON PIN TO CONNECTING ROD		.0004 .0012"
D - CRANKSHAFT PIN DIAMETER		1.0210 1.0215"
W - CRANKSHAFT PIN WIDTH		.9846 .9882"
PISTON RING GAP		.002 .010"
PISTON RINGS – SIDE CLEARANCE IN GROOVES		.0004 .0030"
PISTON PIN TO PISTON		.00035" tight to .00039" loose



Piston, ring, and rod clearance specifications



Measuring points for dimensions critical to crankshaft end play adjustment

GEAR COVER AND CRANKSHAFT INSTALLATION

1. In reassembly, inspect the crankcase oil seal and main bearing for possible replacement. Mount the crankshaft with extreme care so as not to damage the lips of the oil seal. Use an oil seal sleeve if available.

2. End Play is regulated by means of the adjusting collar at the gear end of the crankshaft. This should be set immediately before mounting the gear cover as explained below.

NOTE: *Crankshaft End Play is regulated by the length of the adjusting collar. The end play should be 0.001 to 0.009 in., engine cold. The adjusting collar is located between the crankshaft gear and main bearing at the take-off end of the engine. Replacement of the collar is seldom necessary unless the crankshaft or gear cover is replaced. To determine what length adjusting collar to use, refer to the illustration and steps below.*

1. With the gear cover removed, tap the end of the crankshaft slightly to insure that the shaft is shouldered against the front end main bearing.

2. Use a depth micrometer and measure the distance between the machined surface of crankcase face and end of crank gear (dimension *A*).

3. Measure the distance between the machined surface of gear cover and end of main bearing (dimension *B*).

4. The compressed thickness of gear cover gasket is 0.007 inch (dimension *C*).

5. Select an adjusting collar that is 0.001–0.009 in. less than the total length of A, B, and C from the chart.

6. Apply oil to the bearing surfaces, gear train and tappets. Also lubricate the lips of the oil seal and add a light film of oil on the gear cover face to hold the gasket in place.

7. Mount the adjusting collar to the crankshaft with the recess toward the crank gear.

8. Assemble the gear cover, being sure that the governor yoke is in a downward position, and be extremely careful not to damage the lips of the oil seal. If available, mount an oil seal sleeve on the crankshaft to prevent damage to the oil seal lips.

CAUTION: *Be sure the timing marks on the crankshaft and camshaft gear remain correctly mated when the end of the camshaft is fitted into the bearing hole of the gear cover.*

Adjusting Collar Dimension Chart

Model	Collar Length	Part Number
EY18W	.701 to .709"	EY18D2112a
	.709 to .717"	EY18D2112b
	.717 to .725"	EY18D2112c

Clearances and Wear Limits

Description	Model EY18W Tol	Limit
Flatness of cylinder head	.004	.008
Cylinder bore	2.5591 2.5599	2.5655
Bore-out of round	.0005	.003
Cylindricity (taper)	.0006	.006
Valve seat width	.047 .059	.098
Valve guide bore	.2755 .2770	.280
Piston diameter at skirt thrust faces (standard size)	2.5567 2.5575	2.5535
Piston to cylinder clearance at skirt thrust faces	.0016 to .0032	.008
Ring groove width (top and 2nd ring)	.0985 .0995	.105
Ring groove width (all ring)	.1575 .1585	.164
Ring width (top and 2nd ring)	.097 .098	.0935
Ring width (oil ring)	.1563 .1570	.1523
Piston rings—side clearance in groove	.0005 .0030	.006
Ring gap (at cylinder skirt)	.002 .010	.040
Pin hole in piston	.5509 .5513	.5523
Piston pin diameter	.5509 .5512	.5499
Piston pin to piston fit	.00035 tight to 00039 loose	.0023 loose
Connecting rod (crank pin end)	1.0236 1.0241	1.026
Crank pin diameter	1.0210 1.0215	1.019
Connecting rod to crank pin clearance	.0021 to .0031	.005
Connecting rod side clearance	.0080 .0235	.039
Connecting rod (piston pin end)	.5516 .5520	.5555

Description	Model EY18W Tol	Limit
Piston pin to connecting rod clearance	.0004 to .0012	.0032
Con. rod—large and small bore alignment (parallel)	.002	.004
Con. rod—large and small bore centers	3.9370	3.943
Crank pin—out of round	—	.0002
Cylindricity (taper)	—	.0002
Crank pin—parallel	—	.00032
Crankshaft journal diameter (take-off end)	.9838 .9842	.982
Crankshaft journal (flywheel end)	.9839 .9843	.982
Crankshaft end play	.001 .009	—
Camshaft (cam rise)	1.2087 1.2165	1.199
Camshaft (journal diameter)	.5889 .5893	.587
Valve spring (free height)	1.4173	1.3582
Valve spring (squareness)	—	.039
Valve stem diameter	.273 .274	.270
Valve stem clearance to guide	.0016 .0039	.006
Valve stem—lock-pl. to groove clearance	.0016 .0059	.020
Valve—length from groove to stem end	.1575	.0785
Valve—tappet clearance	.006 .008	.002 .010
Tappet—length	1.811	1.801
Tappet—stem to guide clearance	.0010 .0024	.004
Ignition timing	23° (±2°)	—
Breaker contact opening	.014 (±.001)	—
Spark plug gap	.020 .025	—
Spark plug	14 mm, Champ. L86, AC 44F, NGK B6HS	

9. Tap the gear cover in place with a soft hammer, remove the oil seal sleeve and tighten the gear cover capscrews to *13 ft. lbs. torque.*

10. Tap the end of the crankshaft with a soft hammer so that the crankshaft will shoulder against the main bearing at the flywheel end.

11. Tap the crankshaft in the opposite direction (from flywheel end) to seat the adjusting collar against the main bearing at the take-off end.

12. Attach a dial indicator to one of the $^{5}/_{16}$–24 tapped holes on the face of the crankcase with the indicator plunger resting against the end of the crankshaft and set the dial at 0.

13. Wedge a screwdriver between the flywheel and the crankcase. The movement of the flywheel away from the engine block will register as end play on the indicator dial.

14. If end play is not within the limits of *0.007* to *0.009* in., use the reading from the indicator dial to determine the new length adjusting collar to use. Replace the collar with one of the proper dimension, if necessary.

FINAL CHECKOUT AND BREAK-IN

After the major moving parts are assembled, turn the engine over using the starter pulley. Make sure it turns without unusual resistance. Check the basic ignition adjustments (point gap and timing), and make preliminary carburetor and governor adjustments. Refill the crankcase and fuel tank.

Break the engine in by running it as specified on the chart below, proceeding from top to bottom. Check the engine frequently for leaks, and make final carburetor and governor adjustments during the sequence.

Break-in Sequence

Load	Speed	Time
No load	2500 rpm	10 minutes
No load	3000 rpm	10 minutes
No load	3600 rpm	10 minutes
1.75 hp 2.5 hp 2.65 hp	3600 rpm	30 minutes
3.5 hp 5.0 hp 5.3 hp	3600 rpm	60 minutes

Mechanic's Data

General Conversion Table

Multiply By	To Convert	To	
	LENGTH		
2.54	Inches	Centimeters	.3937
25.4	Inches	Millimeters	.03937
30.48	Feet	Centimeters	.0328
.304	Feet	Meters	3.28
.914	Yards	Meters	1.094
1.609	Miles	Kilometers	.621
	VOLUME		
.473	Pints	Liters	2.11
.946	Quarts	Liters	1.06
3.785	Gallons	Liters	.264
.016	Cubic inches	Liters	61.02
16.39	Cubic inches	Cubic cms.	.061
28.3	Cubic feet	Liters	.0353
	MASS (Weight)		
28.35	Ounces	Grams	.035
.4536	Pounds	Kilograms	2.20
—	To obtain	From	Multiply by

Multiply By	To Convert	To	
	AREA		
.645	Square inches	Square cms.	.155
.836	Square yds.	Square meters	1.196
	FORCE		
4.448	Pounds	Newtons	.225
.138	Ft./lbs.	Kilogram/meters	7.23
1.36	Ft./lbs.	Newton-meters	.737
.112	In./lbs.	Newton-meters	8.844
	PRESSURE		
.068	Psi	Atmospheres	14.7
6.89	Psi	Kilopascals	.145
	OTHER		
1.104	Horsepower (DIN)	Horsepower (SAE)	.9861
.746	Horsepower (SAE)	Kilowatts (KW)	1.34
1.60	Mph	Km/h	.625
.425	Mpg	Km/1	2.35
—	To obtain	From	Multiply by

Tap Drill Sizes

National Coarse or U.S.S.

Screw & Tap Size	Threads Per Inch	Use Drill Number
No. 5	40	39
No. 6	32	36
No. 8	32	29
No. 10	24	25
No. 12	24	17
1/4	20	8
5/16	18	F
3/8	16	5/16
7/16	14	U
1/2	13	27/64
9/16	12	31/64
5/8	11	17/32
3/4	10	21/32
7/8	9	49/64

National Coarse or U.S.S.

Screw & Tap Size	Threads Per Inch	Use Drill Number
1	8	7/8
1 1/8	7	63/64
1 1/4	7	1 7/64
1 1/2	6	1 11/32

National Fine or S.A.E.

Screw & Tap Size	Threads Per Inch	Use Drill Number
No. 5	44	37
No. 6	40	33
No. 8	36	29
No. 10	32	21

National Fine or S.A.E.

Screw & Tap Size	Threads Per Inch	Use Drill Number
No. 12	28	15
1/4	28	3
6/16	24	1
3/8	24	Q
7/16	20	W
1/2	20	29/64
9/16	18	33/64
5/8	18	37/64
3/4	16	11/16
7/8	14	13/16
1 1/8	12	1 3/64
1 1/4	12	1 11/64
1 1/2	12	1 27/64

Drill Sizes In Decimal Equivalents

Inch	Decimal	Wire	mm	Inch	Decimal	Wire	mm	Inch	Decimal	Wire & Letter	mm	Inch	Decimal	Letter	mm	Inch	Decimal	mm
1/64	.0156		.39		.0730	49			.1614		4.1		.2717		6.9		.4331	11.0
	.0157		.4		.0748		1.9		.1654		4.2		.2720	I		7/16	.4375	11.11
	.0160	78			.0760	48			.1660	19			.2756		7.0		.4528	11.5
	.0165		.42		.0768		1.95		.1673		4.25		.2770	J		29/64	.4531	11.51
	.0173		.44	5/64	.0781		1.98		.1693		4.3		.2795		7.1	15/32	.4688	11.90
	.0177		.45		.0785	47			.1695	18			.2810	K			.4724	12.0
	.0180	77			.0787		2.0	11/64	.1719		4.36	9/32	.2812		7.14	31/64	.4844	12.30
	.0181		.46		.0807		2.05		.1730	17			.2835		7.2		.4921	12.5
	.0189		.48		.0810	46			.1732		4.4		.2854		7.25	1/2	.5000	12.70
	.0197		.5		.0820	45			.1770	16			.2874		7.3		.5118	13.0
	.0200	76			.0827		2.1		.1772		4.5		.2900	L		33/64	.5156	13.09
	.0210	75			.0846		2.15		.1800	15			.2913		7.4	17/32	.5312	13.49
	.0217		.55		.0860	44			.1811		4.6		.2950	M			.5315	13.5
	.0225	74			.0866		2.2		.1820	14			.2953		7.5	35/64	.5469	13.89
	.0236		.6		.0886		2.25		.1850	13		19/64	.2969		7.54		.5512	14.0
	.0240	73			.0890	43			.1850		4.7		.2992		7.6	9/16	.5625	14.28
	.0250	72			.0906		2.3		.1870		4.75		.3020	N			.5709	14.5
	.0256		.65		.0925		2.35	3/16	.1875		4.76		.3031		7.7	37/64	.5781	14.68
	.0260	71			.0935	42			.1890		4.8		.3051		7.75		.5906	15.0
	.0276		.7	3/32	.0938		2.38		.1890	12			.3071		7.8	19/32	.5938	15.08
	.0280	70			.0945		2.4		.1910	11			.3110		7.9	39/64	.6094	15.47
	.0292	69			.0960	41			.1929		4.9	5/16	.3125		7.93		.6102	15.5
	.0295		.75		.0965		2.45		.1935	10			.3150		8.0	5/8	.6250	15.87
	.0310	68			.0980	40			.1960	9			.3160	O			.6299	16.0
1/32	.0312		.79		.0981		2.5		.1969		5.0		.3189		8.1	41/64	.6406	16.27
	.0315		.8		.0995	39			.1990	8			.3228		8.2		.6496	16.5
	.0320	67			.1015	38			.2008		5.1		.3230	P		21/32	.6562	16.66
	.0330	66			.1024		2.6		.2010	7			.3248		8.25		.6693	17.0
	.0335		.85		.1040	37		13/64	.2031		5.16		.3268		8.3	43/64	.6719	17.06
	.0350	65			.1063		2.7		.2040	6		21/64	.3281		8.33	11/16	.6875	17.46
	.0354		.9		.1065	36			.2047		5.2		.3307		8.4		.6890	17.5
	.0360	64			.1083		2.75		.2055	5			.3320	Q		45/64	.7031	17.85
	.0370	63		7/64	.1094		2.77		.2067		5.25		.3346		8.5		.7087	18.0
	.0374		.95		.1100	35			.2087		5.3		.3386		8.6	23/32	.7188	18.25
	.0380	62			.1102		2.8		.2090	4			.3390	R			.7283	18.5
	.0390	61			.1110	34			.2126		5.4		.3425		8.7	47/64	.7344	18.65
	.0394		1.0		.1130	33			.2130	3		11/32	.3438		8.73		.7480	19.0
	.0400	60			.1142		2.9		.2165		5.5		.3445		8.75	3/4	.7500	19.05
	.0410	59			.1160	32		7/32	.2188		5.55		.3465		8.8	49/64	.7656	19.44
	.0413		1.05		.1181		3.0		.2205		5.6		.3480	S			.7677	19.5
	.0420	58			.1200	31			.2210	2			.3504		8.9	25/32	.7812	19.84
	.0430	57			.1220		3.1		.2244		5.7		.3543		9.0		.7874	20.0
	.0433		1.1	1/8	.1250		3.17		.2264		5.75		.3580	T		51/64	.7969	20.24
	.0453		1.15		.1260		3.2		.2280	1			.3583		9.1		.8071	20.5
	.0465	56			.1280		3.25		.2283		5.8	23/64	.3594		9.12	13/16	.8125	20.63
3/64	.0469		1.19		.1285	30			.2323		5.9		.3622		9.2		.8268	21.0
	.0472		1.2		.1299		3.3		.2340	A			.3642		9.25	53/64	.8281	21.03
	.0492		1.25		.1339		3.4	15/64	.2344		5.95		.3661		9.3	27/32	.8438	21.43
	.0512		1.3		.1360	29			.2362		6.0		.3680	U			.8465	21.5
	.0520	55			.1378		3.5		.2380	B			.3701		9.4	55/64	.8594	21.82
	.0531		1.35		.1405	28			.2402		6.1		.3740		9.5		.8661	22.0
	.0550	54		9/64	.1406		3.57		.2420	C		3/8	.3750		9.52	7/8	.8750	22.22
	.0551		1.4		.1417		3.6		.2441		6.2		.3770	V			.8858	22.5
	.0571		1.45		.1440	27			.2460	D			.3780		9.6	57/64	.8906	22.62
	.0591		1.5		.1457		3.7		.2461		6.25		.3819		9.7		.9055	23.0
	.0595	53			.1470	26			.2480		6.3		.3839		9.75	29/32	.9062	23.01
	.0610		1.55		.1476		3.75	1/4	.2500	E	6.35		.3858		9.8	59/64	.9219	23.41
1/16	.0625		1.59		.1495	25			.2520		6.		.3860	W			.9252	23.5
	.0630		1.6		.1496		3.8		.2559		6.5		.3898		9.9	15/16	.9375	23.81
	.0635	52			.1520	24			.2570	F		25/64	.3906		9.92		.9449	24.0
	.0650		1.65		.1535		3.9		.2598		6.6		.3937		10.0	61/64	.9531	24.2
	.0669		1.7		.1540	23			.2610	G			.3970	X			.9646	24.5
	.0670	51		5/32	.1562		3.96		.2638		6.7		.4040	Y		31/64	.9688	24.6
	.0689		1.75		.1570	22		17/64	.2656		6.74	13/32	.4062		10.31		.9843	25.0
	.0700	50			.1575		4.0		.2657		6.75		.4130	Z		63/64	.9844	25.0
	.0709		1.8		.1590	21			.2660	H			.4134		10.5	1	1.0000	25.4
	.0728		1.85		.1610	20			.2677		6.8	27/64	.4219		10.71			

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#7056	Chevy Mid-Size 64–82 inc. El Camino, Chevelle, Laguna, Malibu & Monte Carlo
#6841	Chevy II 62–79
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#7059	Cimarron 1982
#7335	Citation 80–83
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#7190	Cutlass 70–82
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#5790	Datsun 61–72
#7196	Datsun F10, 310, Nissan Stanza 77–82
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#7197	Datsun 1200, 210/Nissan Sentra 73–82
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#7345	Firebird 82–83
#7059	Firenza 1982
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#7140	Ford Bronco 66–81
#7341	Ford Courier 72–82
#7194	Ford Mid-Size 71–82 inc. Torino, Gran Torino, Ranchero, Elite, LTD II & Thunderbird
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#7171	Ford Vans 61–82
#7165	Fuego 82–83
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#7035	Toyota Pick-Ups 70–81
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